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Smile!

LIFE is made up of associations. Few men are sufficient unto themselves. We are all dependent for the myriads of impressions and sentiments, feelings and conceptions that make our day happy and enjoyable or gloomy and disagreeable, upon the moods and reactions of those with whom we come into contact.

And when one is free to select, one naturally turns to those who are pleasant and cheery and agreeable, with the effect that the man with a smile wins the preference and the popularity.

He does more than this. He radiates good nature, begets kindliness and contentment and good feeling and makes their day one of sunshine instead of shadow to those about him.

A request denied with good reason and a smile is often more acceptable than a favor grudgingly and ill-naturedly bestowed.

But the smile is simply the outward expression of the mental mood and inward disposition. It must be sincere.

A forced smile is as little convincing and satisfying as is a mask compared with the expressive countenance that it covers.

But when one by force of will overcomes peevishness and irritation and preoccupation, and smiles despite it all, the smile will be a sincere manifestation of the victory of his natural good nature; "forced" by the conquest of his annoyances, not as a cover for a fit of mental distemper.

My plea is, after all, for the natural kindliness and good nature of which the smile is the reflection. These cannot be acquired by any trick adjustment of the facial muscles, and without them the smile is simply a camouflage or a smirk. The criminal may smile at the success of some nefarious scheme, the man with the narrow soul may smile at the misfortune of a competitor. The man whose face was cast with a continual smile misses the opportunity of special expressions of his kindliness. But the man who is full of contentment and good will and disposition to be helpful in making others happy, will express that condition as naturally by a smile as does the aroused watch dog his apprehension by a growl.

The A. S. M. E. Annual Meeting

Large Attendance, Fellowship and Diversified Technical Program Outstanding Features

THE forty-fifth annual meeting of the American Society of Mechanical Engineers just closed, with an attendance of approximately two thousand, measured up well to the previous meetings and in some respects marked an advance, notably in the difficult problem of promoting fellowship in a large engineering society. The greatest factor to this end was the acquaintanceship dinner on Wednesday night which over six hundred attended. Other features were the excellent list of excursions and an instructive program of technical papers. However, the activities of the

George Wallace Melville

society are broadening to such an extent, through its technical sections, as to render necessary several simultaneous sessions each day. This, of course, reacts to the disadvantage of members having interests in papers of more than one session, but appears to be inevitable in a society of the scope of the A.S.M.E.

The program having already appeared in detail in last week's issue, no further reference will be made to it, but abstracts of those papers of particular interest to *Power* readers, together with the high points of the discussion will be found in the following pages.

Reverting to the outstanding social event, the Wednesday night dinner, the idea of the committee this year was to make this event a get-together affair so that the new members would have an opportunity of seeing and meeting the older and prominent men of the society, hearing from them something of its ideals and the opportunities that go with membership.

Accordingly, President Low devoted his remarks to introducing the past presidents, the present and incoming officers of the society, and those members which have been identified with the A.S.M.E. for a period of 35 years or more. Secretary Rice then called the role of new members, each of whom responded by standing up, and thus paved the way for closer acquaintanceship. The two speakers of the evening were Dr. Livingston Farrand, President of Cornell University and Past-President D. S. Kimball. The latter told of the ideals of the society and of the opportunities of membership. "In his society," he said, "the engineer will find opportunity for promoting his profession and making it more useful for humanity. There is no other common ground on which men of varying creeds, social connections, political affiliations or worldly possessions can meet and find community of interest comparable to those fields of thought that are concerned with the search for scientific truth and its application."

Doctor Farrand's short address dealt largely with the increase in human vitality. In the sixteenth century, he said, the average span of life was 25 years; this was increased to 30 in the seventeenth, 35 in the eighteenth, 50 in the nineteenth and 56 in 1920. He traced this increase to biological and scientific discoveries and expressed the opinion that it would be possible to extend this span 20 years during the next fifty-year period by readiness to adopt prescribed habits and accept responsibilities of citizenship. This, of course, must be accomplished by better thinking in which the leadership must come from trained minds. Here is an opportunity for both the medical and the engineering professions to show leadership. While he expressed some concern over the apparent wave of loose thinking and prejudice existing at present, he believed that the underlying idealism of society would eventually prevail.

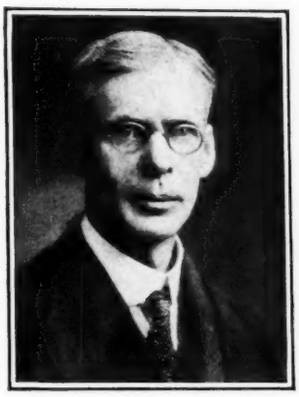
In addition to the technical sessions, the meeting was made the occasion for the presentation on Wednesday afternoon of a bronze bust of the late Rear Admiral George Wallace Melville, former president of the A.S.M.E., and Chief Engineer of the U. S. Navy from 1887 to 1903. The presentation speech, prepared by Walter McFarland, Chairman of the Special Committee, and read by Doctor Durand, the newly elected president of the Society, was a sympathetic summing up of the life of Melville, who was chief of the Bureau of Engineering for many years and who was of great assistance in the introduction of steam on warships. He was also an early advocate of water-tube boilers, putting them in the "Monterey" in 1889 but opposing their use before a suitable type had been developed. Congress presented him with a gold medal for his early work in polar expeditions and rescues, notably his search for the "Polaris," his heroism in connections with the ill-fated "Jeannette" and on the "Thetis" of the Greeley Relief Expedition. After retiring from the Navy he opened up an office where he developed the use of gearing to enable the steam turbine to be adapted economically to marine practice.

Prizes and medals for the best papers written by junior and student engineers were then presented. The awards were: Junior prize to R. H. Heilman of Pittsburgh; Student prizes to (1) G. S. Clark, Stanford University, and (2) to L. J. Franklin and C. H. Smith, also of Stanford University.

On Thursday evening the Carnot centenary was

American Society of Mechanical Engineers

Officers for the Coming Year



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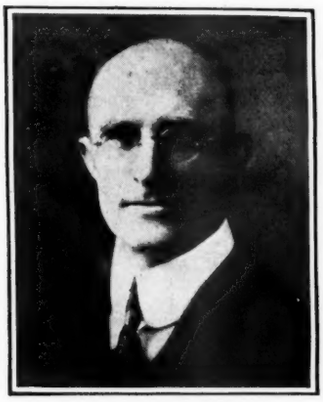

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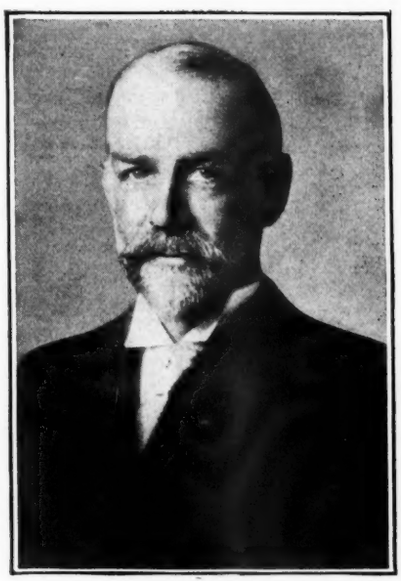

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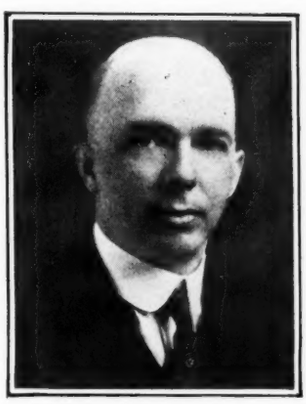

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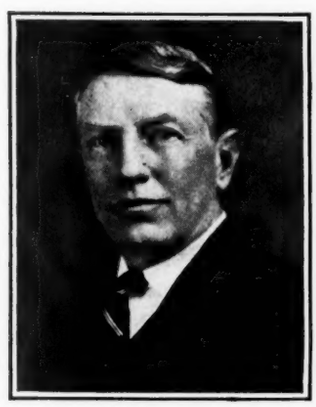


Edward A. Muller
Manager

celebrated under the joint auspices of the engineering societies and schools, two addresses being given; that by Dr. Michael Pupin dealt with "Carnot's Principle," and the other by Dr. Wm. LeRoy Emmett, "Carnot's Influence Upon Engineering." Mr. Emmett pointed out that the duty of the engineer is to go as deep as his understanding requires and to trust to no knowledge which is not firmly established. His dealings are with values, and with other people's money, and his best guide in his profession is a good preception of the dangers of error. He must work with such knowledge as is recorded, or must extend and verify it by experimentation. If he seeks to do anything difficult, or new, he will generally find that little of the recorded knowledge is correct or accurate enough to be safe for his use. If he seeks the truth, therefore, he will feel abounding gratitude to the great mean like Carnot who have given him a few laws which are fundamentally correct and susceptible, in principle, of a universal application.

He pointed out, however, that thermodynamics is a science to which many have contributed and paid high tribute to Rankine and Lord Kelvin, the latter having been the first to complete the statement of Carnot's function and identify it with the absolute temperature scale. Rankine made the calculations upon which our uses of steam are based. The modern engineer has but to devise means by which the possibilities pointed out by these great men can be accomplished. Mr. Emmett then reviewed briefly the contribution of Watt with the steam engine, Parsons and Curtis with the steam turbine, Diesel with the oil engine and finally referred briefly to the experiments with mercury vapor which he himself is now engaged in.

Another session of general interest was that on national defense at which Dwight F. Davis, Assistant Secretary of War, gave an address on "The Engineering of National Defense," Major J. D. Rose a paper on "The Problems in the Design of Ordnance" and Colonel Dixon an illustrated lecture on "The Use of X-Ray Examination of Metals at the Watertown Arsenal." This is made by a 280,000 volt X-ray equipment and has been of great service both to the Ordnance Department and in commercial work in determining defects in steel castings with a view to the redesign of the patterns to eliminate such defects. Among the commercial castings thus examined were those for the 1,200 lb. steam turbine that is to go into the Weymouth Station. The photographs shown by Colonel Dixon very clearly indicated the presence of porous metal, blow holes, sand holes and cracks. Moreover, it is an excellent check on the foundrymen. A final paper by C. Langenberg dealt with "New Developments in Gun Construction."

The excursions were well attended, especially the visit to the Sherman Creek Station of the United Electric Light & Power Co. where six different types of powdered fuel equipment and combustion control are now in operation, also the inspection of the dirigibles Los Angeles and the Shenandoah at Lakehurst, New Jersey. The new Hudson Avenue Station of the Brooklyn Edison Company was another plant that attracted considerable attention from the out-of-town members.

Fuel Supply, Storage and Burning

THREE papers treating of oil burning, one dealing with land plants, one with marine plants and one with the hazards of industrial oil burning, were presented at a session held Tuesday morning.

Oil Burning in Industrial Plants and Central Stations

The paper, "Oil Burning in Industrial-Plant and Central-Station Service," by Nathan E. Lewis, of the Babcock & Wilcox Company, dealt largely with the comparative advantages of steam-atomizing and mechanical burners. The limitation of approximately 200 per cent rating with steam burners, said Mr. Lewis, has led to the wide adoption of mechanical burners for large stations. At the same time the steam burners have certain advantages such as low maintenance cost, good efficiency at moderate ratings, simplicity and low first cost. Hence the steam burner is still widely used in industrial plants. The practical limits of fuel consumption per hour per burner are about 1,300 lb. for steam burners and 1,600 lb. for mechanical. It is practicable to install in a furnace of given width and height more mechanical than steam burners.

As to oil temperatures, Mr. Lewis said that with customary oils the best temperatures lay between 130 deg. F. and 190 deg. for steam burners and between 200 and 280 deg. for mechanical burners. Oil pipe lines must be carefully designed and erected to minimize friction and prevent leakage. In furnace volumes present practise ranges from 0.15 cu.ft. of furnace volume per square foot of heating surface for steam burners in industrial plants to 0.5 cu.ft. for mechanical burners in large central stations. Experience shows that with large furnaces at least 60 lb. of water per hour can be evaporated per cubic foot of furnace volume.

While direct impingement of the flame must be avoided with steam burners, the mechanical burner gives a higher furnace temperature and hence requires better refractories or better protection. Pending the development of better brickwork at reasonable cost experiments are being made with air-cooled walls.

In discussing the relative advantages of steam vs. mechanical atomization, correction was made of some of the fallacies existing as to the relative shape of the sprays. Practice had turned to mechanical atomization, but it was pointed out that the use of steam had advantages and that by the proper location of burners and registers improved results were to be expected. The development of the steam atomizing burner and the advantages in general of the steam atomizing register system were discussed in some detail. The hollow-cone flame of the mechanical burner could be produced by steam, using from 1½ to 2 per cent of the amount generated. The draft requirements were greatly reduced, and the general effect on brickwork was not materially different, as with the same type of flame, it made no difference how it was produced.

Deterioration of refractories in oil burning and methods being introduced to keep the brick cool, such as ventilating the furnace walls, increasing furnace volume and ducts under pressure from the forced-draft fans, were considered.

In blowing cold air onto the outside of refractory brick, it was pointed out that the first movement at low velocity brought down the temperature rapidly, and as the velocity of the air increased, the temperature of the brick came down to a fixed point and then stopped, so that when this point was reached, there was no advantage in blowing additional air. Cooling the exterior of the brick did not reduce materially the temperature at the inside surface as the great absorption of heat here overcame the cooling effect. In certain test work there had been a change of temperature on the outside of 200 deg. and at the inside surface the variation was so slight as not to be readable. The cooling had the advantage, however, of reducing the penetration of the heat and giving the greater part of the brick better body. The air did not have to be cold, as there was a wide range below furnace temperatures.

It was important to notice that with pressure in the furnace the brick became soft farther out. The brick should be glazed over as soon as possible as the glazing reflected the heat instead of absorbing it and this had a marked effect on furnace upkeep.

As to troubles generally credited to oil burning, these in many cases might be due entirely to local conditions. For example, the loss of tubes might be due to increased rating and scale trouble rather than to the fact that oil was being burned.

Fuel Oil in the Navy

Since its first experimental use on capital ships in 1910 the kind of fuel oil used in the Navy has passed from a very light (Diesel oil) to crudes as heavy as 12 deg. B., according to Lieut.-Com. H. G. Donald, of the Philadelphia Navy Yard, who presented a paper on "Fuel-Oil Burning in the United States Navy." Only mechanical atomization is used, he said, and a single type of burner has been made standard for fighting ships. With a choice of orifice this can burn from 150 to 2,000 lb. of oil per hour.

The excess air has been cut down to 15 per cent. Boiler rooms under pressure are used at maximum ratings, but blowers are supplied on the burners to permit economical operation at low ratings.

The speaker said that present practice with the standard small-tube boiler calls for the burning of one pound of oil per square foot of heating surface. About 78 per cent efficiency can be obtained without economizer. There is practically no trouble with refractories.

In the discussion fuller detail was given of the tests on the White-Forster small-tube water-tube boiler mentioned in the paper. It was pointed out that marine practice in oil burning had lagged behind developments on land, but that oil burning afloat was now approaching conditions obtaining in the stationary plant, particularly in larger furnace volumes and in the exposure of heating surface to the radiant energy of the fire. In reply it was pointed out that these developments could not be carried too far as it was necessary to have furnace temperatures of 2,600 to 2,800 deg. F. to support combustion. In burning oil in the marine furnace the main difficulty was to maintain a sufficiently long flame without having it chilled by the heating surface.

Questioning on the difference in CO_2 between the large and small burners used in the tests brought out the reply that it was a question mainly of the quantity of oil being burned and the amount of excess air it was necessary to use to keep the flame from getting into the tube bank. About 11.5 per cent CO_2 had been recommended for the larger burner at two-thirds capacity, but the test figures had come out nearer 12.5 per cent.

In selecting oil, degrees Baumé did not mean much, as such data gave no indication of what the viscosity would be at any given temperature. Viscosity was the property that determined the size of the oil particles, the openings in the burner and the amount of air required to keep down smoke. A viscosity curve then was the principal thing to obtain from the oil companies. From this could be determined the proper oil temperature to give best atomization and permit reduction of excess air.

Hazards of Industrial Oil Burning

In a paper on the "Hazards of Industrial Oil Burning," H. E. Newell, of the National Board of Fire Underwriters, said that, despite some opposition, the requirement of 150 deg. F. for the minimum (closed cup) flash test was generally accepted as reasonable. This requirement prevents the use of "untopped" crude oil. Numerous fire and smoke damage losses have been caused by the use of untopped crudes.

All asphaltum-base oils require preheating for pumping on account of their viscosity. National Board regulations prohibit heating oil in storage to more than 40 deg. below the flash point. There is some doubt as to the necessity of this requirement, but, in the absence of conclusive data, it is sound engineering to be conservative.

Outside underground storage, said Mr. Newell, is the safest. The use of concrete tanks for underground storage is restricted to oils under 35 deg. B. While less safe than outside storage, storage in tanks buried below buildings has not proved extremely hazardous. Special precautions must be taken with inside tanks. The lightning hazard with outside tanks may be avoided by all-metal construction (including roofs) if the tanks are properly constructed, grounded and vented.

The venting of tanks must be designed to meet the condition of excessive evaporation when exposed to the heat of near-by fires. The 20x20 mesh screen, commonly used to prevent backfiring through vent pipes, is of doubtful value. More research needs to be done on the proper size of vent mesh. Even 40x40 mesh has proved insufficient on large vent pipes.

Extra-heavy fittings and piping, according to Mr. Newell, should be used for oil pressures in excess of 100 lb. Piping installations should be tested at a pressure 50 per cent in excess of the working pressure. The piping should be protected against mechanical injury. In case of fire it should be possible to shut down the oil pumps without passing through the boiler room. When starting up a new oil system or one that has been shut down for a long time, care should be taken that the system is freed from dirt by thoroughly blowing through with air. For lighting, a hand torch 3 ft. long should be used, the fireman standing well away to prevent injury from a flareback. To avoid flarebacks, oil should not be permitted to accumulate in the furnace. No attempt should be made to relight a burner from the hot brickwork. When a flareback occurs, close the master oil valve, speed up the blowers and shut down the oil pumps. All dampers should be open and vents clear before lighting. The temperature of the oil should never be raised above the flash point in any part of the system.

Discussion turned to the proper protection of pipes and tanks laid underground and the absence generally of serious corrosion. Complaint was made that restriction on oil installations were unnecessarily rigorous. As a fire hazard, however, it was pointed out that crude oil was more to be feared than gasoline, the reason being that crude oil had all the lighter volatiles of the gasoline and in addition the boiling-over hazard. Reference was made to the advantage of installing steam and oil pipes in the same trench, as the heat from the steam dried out the moisture and at the same time heated up the oil.

The American Petroleum Situation

In an illustrated address on Tuesday afternoon, Dr. Julian D. Sears, U. S. Geological Survey, gave a review of the present petroleum situation in which he discussed the hazards of the industry, its demoralization during periods of over production, the large increase in demand and the possible increased economies in utilization so as to conserve our remaining supply.

While a few have been made wealthy from the production of oil, many have lost heavily. Wells cost from $10,000 to $100,000 to drill, some more, and the percentage of dry wells is very high, amounting to 49 per cent in 1918; in fact in 1923 less than 2 per cent of the wells yielded 50 per cent of the oil and 50 per cent of the oil wells averaged less than 4 barrels per day.

Aside from this, owing to the present laws under which oil is exploited, it is impossible to control the industry and therefore impossible to arrive at any balance between supply and demand. As a consequence, often very large quantities have to go into storage where the loss by evaporation is high, in addition to the cost of keeping the oil in storage. This was particularly true last year with the great production in the California fields, the output being shipped through the Panama Canal and competing with the mid-continental oil, the latter having to be sold at a loss or put in storage. The curve for 1924 was similar to that of 1923 although the peak was not as high. Estimates for this year are that the supply will exceed the demand by about 25,000,000 barrels. The speaker expressed the opinion that the demand is continuing to grow and cited the increased use in marine work as a large factor. The railroads in 1923 consumed 45,000,000 barrels and the Navy takes 6,000,000 barrels annually.

The present estimate of oil in the ground is about 7,000,000,000 barrels and at the present rate of consumption we will, by next March, have consumed one-half of our supply. At the 1923 rate of consumption the remaining supply would last only ten years. However, all the wells will not be discovered in the next ten years and instead of absolute depletion it will mean decreased supply and consumption. These predictions, of course, are based on the present methods of production and use. These are, to a large extent, wasteful and by improved methods of both production and utilization the supply may be made to last very much longer. Although we produce 72 per cent of the world's oil, only 18 per cent of the world's reserves are controlled by this country.

Mr. Sears then touched upon oil shale as a possible source of supply when the present wells shall have become exhausted. Oil shale in this country can be made to produce 55,000,000,000 barrels of oil. Unlike oil wells, it can be kept in the ground without deterioration until needed, but inasmuch as a barrel of oil will require a ton of shale to be mined, the labor incidental to its production is considerable, hence the cost will be correspondingly high. He suggested that the Government appropriate $90,000 for research into shale oil production methods.

Recent Developments in Anthracite Burning

In the final paper of the steam-power session W. A. Shoudy, superintendent of steam stations, Adirondack Power and Light Co., and R. C. Denny, of the Combustion Engineering Corporation, outlined some recent developments in the burning of anthracite. The paper described successive furnace designs tested at the Amsterdam (N. Y.) station of the Adirondack Power & Light Corporation. The coal referred to was anthracite of which at least 95 per cent will pass through a $\frac{3}{16}$-in. round-mesh screen and less than 20 per cent through a $\frac{3}{32}$-in. round-mesh screen. Coxe traveling-grate stokers were used, two to a boiler. The boilers were of the horizontal water-tube type with 13,450 sq.ft. of heating surface each.

As brought out in the paper, the customary furnace design, with only a single short arch over the front half of the grate, has the following disadvantages: Tendency to stratification of gases, high carbon content of the ash, loss of fines to ashpit and stack and lack of flexibility. The first experimental furnace had, in addition to the ignition arch, a very short arch over the rear of the grate. This arrangement showed only a slight improvement. A three-arch experimental furnace was then constructed with better results but with trouble from slagging. The final design was a two-arch furnace (one front and one rear) with a restricted gas passage. With this design excellent results were obtained with low-grade fuel with 30 per cent ash and of which 60 per cent (known as "undersize") would pass through a $\frac{3}{32}$-in. round-mesh screen. Ratings of 300 per cent were attained, whereas 190 per cent was about the limit in the single-arch furnace. The authors pointed out the economic value of this development in the better utilization of low-grade fuel.

Applications of Powdered Fuel

A paper by Henry Kreisinger, research engineer with the Combustion Engineering Corporation, reviewed the recent applications of powdered coal in steam boilers, the paper being confined mainly to the indirect system of firing as applied to large central-station boilers. The two main problems in designing a furnace for powdered fuel, said Mr. Kreisinger, are the prevention of the erosion of the walls and the easy removal of the ash at the bottom of the furnace. The present trend toward nearly complete water cooling apparently promises a positive solution for these two problems. Water-cooled side walls are now frequently used in addition to the water screens over the bottom and back wall of the furnace.

Mr. Kreisinger said that powdered coal could never be a complete success until the boiler was built around the furnace. While he expressed a preference for water-cooled walls for high ratings and coal with fusible ash, he said that hollow air-cooled walls were preferable from the viewpoint of safety, because the inter-space reduced the chance of back puffs igniting dust in the boiler room. For this reason he thought it might be well to make limited use of hollow walls in connection with water cooling.

The two main purposes of the relatively large fur-

naces used with powdered coal, the speaker said, are to obtain complete combustion and to avoid impingement of the flame against the furnace walls, especially with refractory-lined furnaces. To insure complete combustion of the coal particles, the furnace must be large enough to keep them in suspension in the combustion space for one or two seconds.

Speaking of coal driers, Mr. Kreisinger said that in general coals from the Appalachian and Eastern coal fields may be pulverized and burned without drying, while coals from the Illinois and Western coal fields must be partly dried before pulverization. The trend, he said, is toward a small drier that will dry the coal to a sufficient extent as it moves toward the mill. Such driers are built in the form of an enlarged coal chute and are heated either by exhaust steam or by flue gases. The driers extract from 2 to 4 per cent of moisture and preheat the coal so that it loses additional moisture in the pulverizer.

Flue-gas-heated driers require about one-quarter of the total flue gases. They are adaptable to plants where the flue gases are above 300 deg. F. and the driers fairly near the boiler room. Where the coal is passed over steam-heated grids, a small amount of air must be drawn through to carry off the moisture.

At present most mills grind from 5 to 9 tons per hour, although capacities up to 18 tons are being installed. There is a demand for a 50-ton mill. A real impact mill might combine high capacity, low power consumption and small wear.

Mr. Kreisinger closed his paper with the data of tests of powdered-fuel installations in seven different plants. From five to thirteen tests were made in each installation. Table I summarizes the results in terms of the average efficiency of boiler and superheater:

TABLE I—SUMMARY OF PRINCIPAL RESULTS (AVERAGED) OF TESTS ON POWDERED COAL INSTALLATIONS

Plant	Type and Size of Boiler	Per Cent Rating Developed	Efficiency of Boiler and Superheater, Per Cent	Approx. Heat Value of Coal as Fired, B.t.u.
Cahokia	18,010 sq.ft., horizontal water-tube	.....	83	11,700
River Rouge	26,470 - sq.ft., inclined water-tube	150 to 286	80.5	13,300
Rochester Gas & Electric	8,750 - sq.ft., inclined water-tube	157 to 199	79.7 (83.5 with economizer)	13,300
Springdale	15,326-sq.ft., horizontal water-tube	214 to 442	79.8	13,300
Penn Salt Co.	8,220 - sq.ft. horizontal water-tube	101 to 221	82.5	12,600
United Railways (Providence, R. I.)	12,660-sq.ft., inclined water-tube	175 to 324	81.3 (87.2 with economizer)	13,800
United Railways (Providence, R. I..).	12,660-sq.ft., inclined water-tube	157 to 272	79.8 (86.5 with economizer)	11,200 (Mixture of New River and Rhode Island Coal)

Discussion on Powdered Coal Brings Out Diversified Opinions

C. G. Spencer opened the discussion by outlining the development in furnace design at Cahokia. Water-cooled side walls had given place to fin type protection and in the latest furnace tubes on wide centers placed in recesses were being used, the last named method being an intermediate step between water and air cooling. In reducing erosion of walls at high ratings, water cooling had been more effective than the ventilated wall. It was necessary to proportion furnace volume and flame travel for the specific fuel as there was a wide variation in requirements, and another factor to be considered was the tonnage of coal and ash to be handled in producing the same amount of steam as well as the iron content of the coal.

Prof. A. G. Christie referred to the destruction caused by molten ash, the action varying with the coal and being more severe with a low-fusing ash and coal with a high iron content. The washing action might be prevented by walls of neutral brick or water-cooled iron side walls. It had not been demonstrated fully what effect the rapid absorption of the radiated heat might have on the efficiency. Attention was called to a furnace now under construction with water-cooled reverberatory walls that should meet all requirements. Drying was important, as the coal with the least moisture should, for equal results, burn in a smaller furnace and with shorter flame travel or at higher efficiency in the same furnace.

Alfred Iddles compared the results obtained with powdered coal at Cahokia and the stoker-fired boilers at Colfax in an effort to locate the gain of 4 to 8 per cent in efficiency usually credited to powdered coal. The boilers were similar in type and size and the furnace volumes practically the same, so that similar performances from the boilers themselves was to be anticipated and the difference in efficiency found in the economy of fuel burning. By plotting the data in curve form, it was found that the radiation and unaccounted for losses were practically the same. This applied also to the losses from water vapor. The dry flue-gas losses were a trifle lower with powdered coal, but the 8 per cent higher heat absorption with the powdered-coal installation was found to be largely in the reduction of combustible material in the ash. This clearly indicated where stoker builders and users should seek improvement.

John H. Lawrence, of Thomas E. Murray, Inc., stated that in spite of dire predictions, successive improvements in water-walled furnaces had been installed at Hell Gate and Sherman Creek. The stoker-fired boilers of this type at Hell Gate showed an efficiency of 84.5 per cent without an economizer, which proved conclusively that combustion was not injured by the water walls. Recent tests, he said, showed that water walls directly or indirectly exercise a cooling effect on the refractory walls, this amounting in certain cases to 200 degrees.

The six boilers recently constructed for powdered fuel at Sherman Creek are set only 12 ft. high and are equipped with water-cooled side walls. Preliminary tests indicate high efficiencies at 160 to 180 per cent rating. In spite of the small furnaces, ratings up to 200 per cent have been obtained.

He pointed to this as a demonstration that powdered coal could be burned at a high rate in water-cooled furnaces. Mr. Lawrence felt that the development of a new type of burner with a short flame would permit great reduction in powdered-coal furnace volumes without loss of efficiency.

The point of view of the stoker man was presented by W. A. Shoudy, of Schenectady. He said that some of the problems in the East could not as yet be solved by pulverized coal. Admitting that operating efficiencies with pulverized coal ran closer to test efficiencies than stokers, he suggested that this was due in a large measure to more skilled operation. Given scientific control and men trained from the ground up to follow orders, he felt that he could cut down the operating margin of pulverized fuel.

The same point was made by Mr. Keating, of the Westinghouse Electric & Manufacturing Co., who suggested that the use of automatic control with stokers

would reduce the differential. To prove that stokers could handle bad coal, he presented tests made with western Kentucky screenings of about 12,000 B.t.u. containing from 12 to 14 per cent of ash with a fusing point of 1,900 deg. F. Of this fuel as high as 75 lb. per sq.ft. per hour was burned, with a maximum of 14 per cent combustible in the refuse.

Reheating Cycle with Steam Turbines

As an abstract will appear in a later issue, only a brief summary will be given here of the paper, "The Increase in Thermal Efficiency Due to Resuperheating in Steam Turbines," by W. E. Blowney (Turbine Engineering Department, General Electric Co.) and G. B. Warren. The principal conclusions follow: Reheating shows little theoretical advantage. Any practical gain must be found in the better turbine efficiency due to delaying the appearance of moisture. Percentage gains mentioned hereafter mean the percentages of the original efficiency.

Calculations indicate a decrease of 1.15 per cent in turbine stage efficiency for each per cent of moisture in the stage. It is interesting to note that the actual gain by resuperheating is greater at higher initial pressures, whereas the theoretical gain is lower at the higher pressures. This difference is due to the fact that, with high initial pressure, a greater portion of the turbine is operating in the moisture region, and so is susceptible of greater improvement. The best point for resuperheating comes at one-fifth to one-sixth the initial pressure. This best point is not necessarily that at which the steam in the turbine loses its superheat. With initial steam at 1,000 lb. and 750 deg., the gain from resuperheating at the best point is about 7 per cent for one-stage reheating, 10 per cent for two and 12 per cent for three stages. In general, the cost of multiple stage reheating seems hardly justified. Reheating permits a substantial reduction in condenser capacity.

There seems to be no practical objection to extracting superheated steam for feed heating. The gain resulting from a combination of reheating and bleeder feed heating is about 95 per cent of the sum of the gains of the two used separately. It is slightly more economical to extract steam for feed heating just above or at the resuperheating pressure and before the steam has been resuperheated, rather than just after resuperheating.

The Thursday morning session on steam power was given over to the presentation and discussion of papers on water treatment, resuperheating, powdered coal and the burning of anthracite coal.

New Method of Feed-Water Conditioning

In his paper on "Water Treatment for Continuous Steam Production," R. E. Hall, physical chemist, United States Bureau of Mines (Pittsburgh Experiment Station), outlined the necessary conditions for the prevention of scale and corrosion. The conclusions stated represented the results of 2½ years of investigation carried out by the Bureau of Mines in co-operation with the Hagan Corporation. A full understanding of this work requires a knowledge of physical chemistry, but the main points can be outlined briefly.

Proper water treatment, according to Mr. Hall, not only gives control over corrosion and the formation of scale, but also has much to do with the delivery of dry steam and the maintenance of minimum blow-down. Boiler scales are divided into two general classes: Those consisting largely of calcium carbonate and occurring in the feed lines mainly and those consisting mainly of calcium sulphate, magnesium sulphate and magnesium silicate, and constituting the hard adherent scale that forms on the evaporating surfaces of the boiler.

The formation of the calcium carbonate scale occurs because of the slowness with which the calcium salts attain equilibrium, and because of the decrease in solubility of calcium carbonate with temperature decrease. Its formation may be prevented by allowing a sufficient time after proper treatment (as with lime and soda ash) for complete equilibrium to be established, or by permitting a sufficient number of small crystals of calcium carbonate to be present in the water leaving the heater so that a minimum of supersaturation may occur. For removal of this scale, Mr. Hall suggested the use of carbon-dioxide-saturated cold water,[1] or a very dilute solution of a stronger acid in the hands of a competent chemist.

The formation of magnesium silicate in scale is minimized by those conditions which prevent calcium sulphate scale formation. Hence the criterion for preventing the formation of hard, adherent scale in boilers is that of preventing solid calcium sulphate formation in the boiler water. This can be done only if the excess of soda ash or other suitable treating chemical (as sodium phosphate) in the boiler water is based on the pressure at which the boiler operates and the concentration of sulphates in the boiler water. The determination of the latter should be made upon the boiler water itself. For boilers operating at pressures above 200 lb. gage the suggestion was made that the use of sodium phosphate might be more economical than that of soda ash.

Mr. Hall said that deaëration was the best method of preventing corrosion in feed lines and economizers, but soda ash would generally inhibit corrosion in boilers. He listed the following methods of reducing the evil effects of priming and foaming: Regulation of concentration of soluble solids by blow-down; control of suspended solids by filtration of the treated feed water, or continuous filtration of a part of the treated boiler water; separation of the particles of moisture in the steam by mechanical purifiers.

The control of blow-down is based on the moisture condition of the steam and the concentration of sulphate in the boiler water. It is the control of this latter factor which determines the possibility of preventing calcium-sulphate scale formation. Experience has shown that a sulphate concentration of 2,000 parts per million is satisfactory at around 150 lb. gage pressure.

Exception to some of the conclusions in the paper of Messrs. Blowney and Warren was taken by Linn Helander of the Westinghouse Electric & Manufacturing Co. For one thing, consideration of the losses in the reheater piping would have affected the results considerably. The results given agreed in a general way, said Mr. Helander, with previous studies in showing the best single reheating point to be at about one-third of the adiabatic heat drop. For combination of reheating with the regenerative cycle he felt that this point might be changed profitably to about 22 per cent of the adiabatic heat drop. He felt that, particularly in stations with 3 or 4 bleeding stages, more than one stage of reheating could hardly be a commercial proposition.

Prof. Ellenwood, Ithaca, New York, asked why the data on which the paper was based have not been

[1] See *Power*, Oct. 7, 1924, "Use of Carbon Dioxide in Removing Boiler Scale."

made public. He also expressed surprise that data were not available for much higher pressures than 220 lb. Another feature criticized by Prof. Ellenwood was the absence of cost data and the failure of the authors to take into account piping losses. These losses, he said, increased with the number of reheating stages.

Some interesting points were brought out by B. N. Broido, consulting engineer, The Superheater Co. Mr. Broido stated that the factor of 1.15 per cent reduction in stage efficiency for each per cent of moisture was based on laboratory tests of new turbines with smooth blades. Erosion, dirt, etc., he felt would raise this figure to 1.5 or 2.0 for ordinary commercial conditions. The practicability of resuperheating to 750 deg. was questioned. The boiler could hardly house the superheater required to accomplish this at, say, 70 lb., said Mr. Broido. He suggested reheating to 500 deg. by live steam and showed a slide of a heater now on the market for the purpose. The steam to be reheated passes through a shell over coils heated by the high-pressure steam. This apparatus is installed in the turbine room.

The discussion showed a lively interest in the new principles of feed-water conditioning, as outlined by R. E. Hall.

Albert A. Cary, consulting engineer, New York, related some unusual experiences with bad water to show what a great variety of effects is possible in practice. Much difficulty with bad water, he said, is due to the fact that the lower tubes of water-tube boilers are only half full of water, the top halves being full of steam.

After more than a year's experience with the methods of water conditioning, a representative of the General Motors Co. reported satisfactory results. The experiments were made at six widely separated plants of the General Motors Co. Conditions varied greatly, the hardness ranging from 5 to 15 grains per gallon, with variable proportions of temporary and permanent hardness. The experience of this company, he said, shows that hard scale may be eliminated, only a thin, soft, non-growing scale being deposited.

H. L. Smith of the New England Power Co. termed Mr. Hall's paper the most significant contribution in years to the knowledge of feed-water conditioning and a proof that chemists and engineers were co-operating.

Favorable experiences of the West Virginia Pulp and Paper Co. with the methods under discussion were related by a representative of that company. Prior to December, 1922, when the new treatment was inaugurated, the boiler-water concentration would rise to 3,200 parts per million in four days. The boiler tubes and staybolts scaled badly.

Trouble was also experienced with the clogging of steam mains and turbines, it being necessary to take the latter off the line for cleaning every three or four months. Institution of the new methods soon cracked off the old heavy scale, only a light scale remaining. To prevent foaming the boilers were emptied whenever the concentration reached 3,000 parts per million.

A possible explanation of the advantage of frequent changes from one brand of boiler compound to another was suggested by McRea Parker of the Cleveland Worsted Mills. He had been puzzled by the fact that many compounds would give good results at first and then gradually drop off to a condition of inefficiency that could only be remedied by changing to a new compound. This phenomenon, he suggested, might be due to the gradual concentration of certain products in the boiler.

On account of the great interest in the steam-power papers it was impossible to complete the discussion in the morning session. In fact discussion of the four papers presented filled the entire afternoon. Commenting on Mr. Hall's paper, G. G. Bell of the West Penn Power Co., reported excellent results at the Springdale plant for the past eight months with the methods outlined. They had also found that the necessity for cleaning the evaporators could be entirely obviated by proper treatment and concentration control of the water in the evaporator. When the evaporator water reaches a certain predetermined concentration, he said, it is emptied and refilled. He offered this as a valuable suggestion to the manufacturers and users of evaporators.

A written discussion by Edward O. Mueller of the Centrifix Corp., called attention to the recent perfection of centrifugal devices for removing entrained moisture from steam. The necessity for such devices, even with proper water treatment, had been pointed out by Mr. Hall.

At this point Mr. Hall arose to correct an apparent impression that his system used caustic soda in high-pressure boilers. Instead, he said, he used sodium phosphate. As to the possibility of caustic embrittlement due to the presence of caustic soda, at lower pressures, Mr. Hall stated that the normal maximum of 200 parts per million was safe.

Another closure to the same paper was made by Mr. Warren who felt that the factor of pressure drop in pipes was outside of the field of the turbine designer. Necessary corrections could be made by station designers. Mr. Broido had stated that the laboratory figure of 1.15 per cent decrease in stage efficiency for each per cent of moisture should be increased to 1½ or 2 per cent for practical conditions on account of eroded and rough surfaces. Mr. Blowney did not agree, saying that laboratory tests indicated this loss to be due to internal friction loss and practically independent of the surface conditions. He could see no theoretical objection to heating with live steam, the decision in this matter hanging on commercial considerations.

The Prosser Steam Engine

A paper of much interest was presented by L. V. Ludy, professor of experimental engineering, Purdue University, the subject being a series of tests conducted on a Prosser steam engine, the results equaling those obtainable from unaflow engines.

Ever since the advent of the steam engine engineers have endeavored to improve its economy by devising ways and means of reducing losses in the cylinder. As is generally known, the greatest loss occurs due to the relatively large amount of steam that is condensed in the cylinder before it has an opportunity to expand and do work on the piston. This loss is caused by the alternate heating and cooling of the cylinder walls, piston, etc., made necessary by the cycle employed. In modern steam engines the heating and cooling effect is much less than formerly, but the loss due to this cause is still very great. In studying this phase of cylinder losses in steam engines, J. G. Prosser developed ideas that were incorporated in the Prosser type engine.

The steam-jacketing feature is carried out differently from that of other engines, in that in addition to the cylinder, valve case, and heads being provided with

steam jackets, the piston and rod are hollow and supplied with high-pressure steam abstracted for jacket purposes.

The general appearance of the Prosser engine is quite similar to engines built by several well-known manufacturers. That used in this investigation was a single-cylinder, simple, horizontal, high-speed unit designed for direct connection to an electric generator. Provision was made for supplying high-pressure steam to the steam jacket surrounding the cylinder and valves, to the hollow space of each cylinder head, and to the piston rod. Steam was admitted to the hollow portion of the piston and piston rod through a small tail rod. The condensate that accumulated in the cylinder, valve-case jacket and cylinder-head jackets was conducted by gravity through suitably arranged pipes to a trap below. The condensate from the hollow piston collected in the lower portion of the hollow piston and was removed through a small ball check valve and drain tube by the pumping action of the tail rod. Small hand-operated air cocks in the outer portion of the piston rod and at other convenient places provided a means of removing air from the steam jackets. The inner portions of the surfaces of the hollow piston and cylinder heads were grooved with small spiral grooves in order that the heating surfaces might be more effective. All surfaces of the cylinder block and heads exposed to the outside atmosphere were lagged with asbestos insulation in order to reduce radiation losses to a minimum.

The valve mechanism consists of two piston valves, one being 7 in. and the other 4 in. in diameter. The larger of the two, the main valve, was operated by an eccentric under control of the governor and regulated the admission, cutoff, and release of the steam. The smaller valve was operated by a fixed eccentric attached to the engine shaft, its function being to control the point of compression independently of the main valve. All pockets in the valve chamber which might fill with condensate and wet the surface of the valve in its movement were drained.

With 146 lb. gage steam pressure and atmospheric exhaust the steam consumption was 20.54 lb. per indicated horsepower, while the consumption dropped to 16.7 lb. when 21 in. vacuum was carried. With the same vacuum and practically the same steam pressure but with 100 deg. superheat, the consumption was 14.85 lb. per indicated horsepower.

Discussion of Prosser Engine

Replying to several questions from the floor, Professor Ludy and Mr. Prosser gave as the saving due to jacketing the piston and piston rod 3.48 per cent using saturated steam and 2.23 per cent using superheated steam. The engine as constructed with heads, barrel, piston rod and piston all jacketed represents a saving of 11.49 per cent with saturated steam and 7.33 per cent with superheated steam as compared with an engine having no jacketing at all. The friction loss was given as approximately 8 per cent. In explanation of the engine not being charged with the steam for the condenser auxiliaries, it was pointed out that the auxiliaries available at the University were not of a particularly efficient type and no effort was made to charge their steam against the engine. Mr. Prosser stated that piston valves had been adopted inasmuch as speed limitations had been encountered with poppet valves.

Intakes for Power Plants

A paper, "Intakes for Power Plants," by Robert W. Angus, includes a description and discussion on an extensive investigation made by the author on large scale models, at Niagara Falls, Canada, to determine on a suitable intake for the Chippawa-Queenston development of the Hydro-Electric Power Commission of Ontario, Canada. These experiments were made with different designs and arrangements of under-water tubes extending out into the river, from the entrance of the power waterway like the fingers on a hand. From these experiments the conclusion is drawn that the intakes must be made to draw from lines normal to the shore rather than parallel with it, and an effective design may be made to distribute its suction over a much greater area than it extends.

It is pointed out that the difficulty of the problem depends on the volume of water to be taken in, the depth below the surface at which the intake may be placed, the velocity of the water in the source of supply and on the amount of floating material present. Where there is much ice, the design must be very carefully worked out to be effective. Desirable properties of an intake are summarized as follows:

An intake must be simple in form and easily constructed. This is self-evident when it is remembered that they are used under water and frequently must be constructed without unwatering. Further, the danger of blocking up increases as the intake becomes more intricate in form.

The intake must be thoroughly reliable and positive, even to the extent of sacrificing some efficiency for certainty of operation. It is necessary that an intake should never fail to supply the desired volume of water, and it is therefore better to have a small amount of ice and débris enter it, if necessary, a good part of the time under part loads, than to make the design so complicated as to render it likely to choke up when the draft is heavy. On the whole, an intake that functions properly under full load will have little chance of drawing in débris at other times.

The intake should have a large factor of safety of operation—greater, indeed, than other parts of the plant, partly because of the lack of knowledge of effective design, as demonstrated by the failure of so many intakes under critical conditions. On the other hand, money may be needlessly wasted by making large and ineffective designs. The loss of head in the intake should be small, as it produces a decrease in the effective head on the plant.

A large factor of safety naturally suggests an intake covering a considerable area, but it must be kept in mind that the larger the area occupied the greater the field of ice from which the intake may draw. It is also well know that, while the larger area would tend to decrease the volume of water drawn in from each square foot of surface, yet it may follow that an imperfect design may be little benefited by an increase in size, since the draft may not be equally distributed over the area covered by it.

This statement is evident to anyone observing the action of intakes, for there are many cases where the intensity of draft varies enormously over the area covered by the intake and where the distribution is far from uniform. In fact, it is one of the most difficult things in hydraulics to arrange for a uniform draft of water over a prescribed inlet area.

When laying out a penstock the designer will probably resort to some trial and error to determine the most economical size on account of the large number of variables entering into the problem. It was in an effort to find a more rational way of working out the design that H. L. Doolittle evolved a graphic method, which he presented in his paper, "A Method for the Economic Design of Penstocks." Although the method does not give an exact solution of the problems entering into the design, it is believed to be close enough for all practical purposes. Given a certain flow of water, length of pipe and profile of penstock, curves may be drawn for pipes of varying sizes which indicate the friction loss and its value in dollars. Other curves are worked from which it is possible to determine by inspection the most economical sizes of penstocks. In the method presented, the most economical size of penstock is that in which the sum of the annual value of the power lost in friction and the annual charges for interest, depreciation and taxes are at a minimum. The fundamental principle of the method is as follows:

If a curve be plotted with length of pipe as abscissas and total annual costs per foot as ordinates, the area under the curve will be proportional to the total annual cost of the entire line. The ordinate at any point represents the cost of the pipe at particular position in the line. If several curves are drawn on the same chart for different diameters of pipe, the most economical pipe will be the one made up of the various diameters giving the minimum area between the pipe curve and the abscissas. A problem has been worked out showing the application of the method.

In a written discussion on this paper, Robert L. Daugherty presented an algebraic solution of the problem which is approximately correct and may be used to show within comparative narrow limits where the correct answers lie. With the results of this approximate solution, which can be obtained in a short time, the designer knows just about the diameters and thickness to use in the graphic method and needs to compute only a few of the values otherwise required.

Discussion on Hydraulic Papers

Although all who took part in the discussion of Mr. Doolittle's paper agreed that it was a valuable contribution on penstock design, considerable attention was centered on the question of water-hammer as a factor in the design of penstocks. This factor was neglected by the author in his method of penstock design, and it was pointed out in the discussion that where long penstocks are used on low-head plants, the head due to water-hammer might be of greater importance than the static head. The opinion was expressed that it is not enough to consider the cost of the power save as the determining factor in penstock design. For example, it might be found to be most economical to allow a velocity of 15 ft. per second in the pipe line down to the surge tank, where from the surge tank to the turbine a velocity of one-half this value might be the most desirable, showing that a different law applied in one case than in the other. From the surge tank to the turbine regulation requirements will frequently determine the dimensions of the penstock. After the design has been worked out on this basis, it can be checked for friction losses.

In the discussion on the paper by Mr. Angus, attention was called to a plant on the Canadian border where the average output generated had been increased thirty thousand kilowatts for the four winter months by providing the proper type of intake to keep the ice away from the plant. A design of intake is used at Shawinigan Falls similar to the Johnson and Wahlman design described by Mr. Angus. This intake has been tested and found to conform to within one per cent of calculated results.

Report Progress in Steam Research

As has already been explained at length in *Power*[1], a joint program of steam research under the auspices of the A.S.M.E. is now under way at the Bureau of Standards, Harvard, and the Massachusetts Institute of Technology. The main tasks have, briefly, been distributed as follows: Bureau of Standards—determination of the mean B.t.u., the properties of saturated liquid and vapor; Harvard—determination of the properties of superheated steam by measurements of the Joule-Thomson throttling effect; Massachusetts Institute of Technology—determination of the specific volume of liquid and vapor. As each of these sets of data permits determination of other properties by computation, there will be excellent opportunity for checking the work at each institution against that at the others.

Arthur M. Greene presided at the steam-table session on Wednesday afternoon. Speaking for the committee, George Orrok said that while not much money had been collected recently it was expected that funds would be obtainable as needed. Dr. R. V. Kleinschmidt of Harvard announced the completion of the experimental work on the original program and the checking of the computations. He presented results in the form of Joule-Thomson coefficients at 43 points ranging up to 565 lb. and 657 deg. F.

Dr. Frederick Keyes, of Massachusetts Institute of Technology, presented a progress report, stating that he had completed the calibration of apparatus and the task of filling it with air-free water. Actual observations on the specific volume of the liquid have been begun.

N. S. Osborne of the Bureau of Standards did not present the scheduled paper on "Direct Measurements of the Heat Content of Superheated Steam." He showed, however, parts of the apparatus and said that while he could make no definite predictions, he hoped that by the next annual meeting he would be able to announce the start of actual experimental work.

The following abstract covers the main points of the paper which Mr. Osborne had prepared for presentation at the meeting. Mr. Osborne showed how the Joule-Thomson results obtained at Harvard could be checked by a simple addition to the calorimeter under construction at the Bureau for use in determining the properties of the saturated fluid.

This attachment would consist of a throttling valve within the calorimeter, followed by a coil also within the calorimeter and leading to an external connection through which steam could be withdrawn. The coil being bathed in saturated vapor at the initial pressure, would permit the delivery of superheated steam at the initial temperature and any desired lower pressure.

By measuring the electrical heat input, this apparatus would give the total heat of superheated steam at all pressures obtainable with the calorimeter and at all temperatures below the saturation temperature corresponding to the maximum pressure that could be handled with safety and reliability by the calorimeter.

Lubrication Session

At the lubrication session, H. A. S. Howarth presented a paper on, "A Graphic Study of Journal Lubrication." This paper continues the investigations of journal lubrication reported to the society last year in a paper of the same title as the foregoing. The previous paper dealt with lubrication of bearings that completely surrounded the shaft. This paper covers the subject of partial bearings or bearings that only partly surround the shaft. The method of analysis leads to the formation of charts for the study of partial bearing design problems.

A second paper, "An investigation of the Critical Bearing Pressures Causing Rupture in Lubricating Films," by Leonard Noel Linsley, U. S. N., gives the results of an investigation to determine the critical or break-down pressure in the oil film formed in a bearing, using straight mineral oils, and also to determine the influence on this critical pressure of mixing a definite amount of oleic acid in the oil.

The most important fact brought out in this work is the intensity of pressure that the oil film will stand before being displaced. Even under the most adverse conditions of operation in the experimental work the actual break-down pressures are several hundred times the values that have hitherto been accepted as possible. The results with oils treated with oleic acid indicate that the break-down pressures are less than with straight mineral oil. However, the author points out that this effect should not be taken as conclusive on account of the meager amount of experimental work done with treated oils.

"High-Pressure-Bearing Research," by Louis Illmer, supplements an earlier paper by the author relating to high-speed bearings working under moderate pressures. This paper is directed especially toward the intermediate field of friction that lies between perfect-film lubrication and dry-metallic friction. As compared with the friction coefficient for perfect lubrication, the breaking down of the oil film introduces a number of additional variable factors that affect such coefficients and their changes with conditions of service. Certain constants are therefore presented to serve as a guide in appraising the various modifying factors, appropriate for any given set of operating conditions under partial lubrication.

During the discussion it was brought out that the strength of an oil film against breakdown in a bearing had been greatly underestimated. The results of tests made by other investigators tended to corroborate those found by Mr. Linsley regarding the high breakdown pressures of oil films in bearings. The results given by Mr. Linsley in his paper were those obtained by starting the shaft revolving under light loads and getting it well lubricated after which the load was increased to where the oil film failed. This condition is the reverse of that found in practice, where the full load on the bearing may exist at standstill and the shaft must start with practically a metal-to-metal contact, therefore the loadings given in Mr. Linsley's paper were considered as not applying to practical conditions.

The importance of proper fit of the journal and bearing was emphasized, if satisfactory operation was to be obtained under heavy loading. In corroboration of this attention was called to large-sized bearings that were operating satisfactorily with loadings of 1,600 lb. per square inch of projected area and a shaft speed of 3,000 to 3,500 ft. per minute. These bearings had been carefully fitted before being put into service.

Viscosity of the oil was considered an important factor in satisfactory operation of bearings. On account of a high-viscosity oil having a tendency to cause a higher temperature in bearings, its actual viscosity at bearing temperatures might not be any higher than for a grade having a lower viscosity and operating with a lower bearing temperature. Although practical experience with acidity of turbine oil would apparently bear out Mr. Linsley's findings, that oils treated with oleic acid breaks down at a lower bearing pressure than straight mineral oils, the opinion was expressed that there was no relation between the two conditions.

Zoelly Turbine-Driven Locomotive

In a paper presented by Henry Zoelly, chairman of the Board of Directors of Escher Wyss & Co., Zurich, Switzerland, two locomotives are described, one of which, driven by a 1,000-hp. turbine, has been built and tested, and the other, of the same general type but of 2,000-hp. capacity, is not ready for test.

In this instance a standard piston locomotive of the Swiss Federal Railways, type D-$\frac{3}{4}$, has been reconstructed for turbine drive in the same general capacity. Its maximum speed is 47 miles, boiler pressure 200 lb., total temperature 662 deg. F. and boiler-heating surface 1,060 sq.ft. There are six driving wheels, each of 5-ft. diameter. The pistons were removed from the forward part of the locomotive, and a jackshaft placed in this location which is connected by main rods to the drivers. The six-stage Zoelly turbine of 1,000-hp. drives the jackshaft through two reduction gears, one of which has a ratio of 1 to 7 and the other 1 to 4.1. For reversing, an auxiliary-multi-velocity stage wheel is mounted on the same turbine shaft.

The turbine makes 7,500 r.p.m. going 47 miles per hour, and is supplied with two valves, one for normal load and one for overload, each leading to separate groups of nozzles. One passage admits 11,000 lb. of steam when fully open, and the other 4,400. Separate condensers are placed on each side of the locomotive, the water being pumped to the trailing car, where a special air-cooling device is installed. The feed water is heated by exhaust from turbine-driven auxiliaries.

It has only been possible to make four tests over a 35-mile track, in which the coal consumption could not be measured.

The 2,000-hp. locomotive has just been completed and will shortly be ready for test. The turbine extends entirely across the front of a locomotive in the same relative location as the other units, and the condenser, instead of being placed one part on each side, representing two units, is also in a crosswise position underneath the boiler. Turbine gears and driving jackshafts are mounted on a steel casting which can be slid under the main frame of the locomotive and bolted in place. The main turbine is designed for 215-lb., 662-deg. F. steam, with a speed range normally of 6,000 to 8,000 r.p.m. An economizer, from the escaping stack gas of 750 deg. F., heats the feed water from 122 deg. to about 217 deg. It is possible that bled steam will further be utilized for feed heating and that air preheating will be added.

The unsuitability of the steam turbine for starting on high gear was mentioned in a short discussion.

The Internal Combustion Engine

Three comprehensive papers on the internal-combustion engine were presented at the Thursday afternoon session held under the auspices of the Gas and Oil Power Division. The quality of the three papers, as well as the large attendance, indicates an increase in the attention given to gas turbines and oil engines as prime movers. Of special significance is the fact that the solid-injection oil engine was the subject of a paper read at the last winter's meeting as well as of a paper at the current meeting.

Solid-Injection Oil Engines

The high points of the design of a new solid-injection engine were brought out in the paper of Rudolf Hildebrand, chief engineer of the Diesel Division of the Fulton Iron Works Co. The speaker pointed out that there are two typical forms of combustion chambers, one of which aims to create a violent turbulence of the air charge, while the other utilizes only the natural turbulence set up during the charging stroke. Violent turbulence is not necessary if the combustion chamber and other parts are designed correctly, and is objectionable by reason of the high radiation losses.

In designing the Fulton-Hildebrand engine the decision was to utilize the space between the piston and cylinder head as the combustion chamber. In locating the fuel nozzles, two of which are used, there was some doubt as to whether the opposing nozzles would form the best arrangement, it being the existing theory that the oil sprays would not go beyond the center of the combustion space. Experiments demonstrated that the fuel actually penetrates the entire cavity, provided it is not burned before reaching the opposite walls. It was found that, with the sprays opposed and meeting at the center, the fuel consumption was excessive owing to oversaturation of the center of the charge, although with violent turbulence the mixing is enhanced and a clear exhaust shown. The nozzles were then offset so that the sprays could not meet; this entailed modifications of the piston crown to accommodate the sprays. It was found that the engine could carry even a 40 per cent overload with a clear exhaust.

A cam-operated pump having an increasing plunger velocity usually gives too fine an atomization, and a pump with a constant velocity was designed. This is driven from the engine shaft and is of the impact type. The fuel nozzle has one central orifice and a fluted plug to give a whirling motion to the oil. The engine is able to carry a mean effective pressure of well over 100 lb. per sq.in. without distress and with an excellent efficiency.

In commenting on the paper, J. W. Anderson stated that the greatest portion of the turbulence in the Price engine was due to the effect of the air flow through the admission valve. It was not the belief of the Price engine designers that the oil penetration was small; to the contrary the two opposing sprays were used to prevent the oil striking the cold opposite walls. He also doubted the statement that a cam-operated pump was unsatisfactory.

H. Schreck stated that the reason for the difference in the results with the Price and the Hildebrand opposed sprays was found in difference in combustion-chamber design. In the former engine the mass of hot air was at the center while in the Hildebrand engine the hot core shifted toward the sides of the cavity.

Why the Gas Turbine Is Impracticable

In an extensive paper on Gas Turbines, Lionel S. Marks, professor of mechanical Engineering, Harvard University, and M. Danilow, Research Department, General Electric Co., outlined the theoretical possibilities of both the constant-volume and constant-pressure types of gas turbine.

It was stated that the common expectation of improved efficiency of the turbine over the reciprocating internal-combustion engine rested on an analogy with the steam turbine, but unfortunately these expectations were groundless. The gas turbine will always show a lower efficiency than will a reciprocating engine operating over the same pressure range. It cannot hope to compete with the engine in small powers, and in large units it falls below the efficiency of the large steam turbine. It was pointed out that the actual construction of the gas turbine offers a number of practical difficulties by reason of the high average temperature of the combustion chambers and blade disks. This casing temperature will be around 850 deg. F. and limits the blade material. Holzwarth uses soft electrolytic iron, while Rateau makes use of tungsten steel. The permissible casing temperature limits the turbine design so that maximum efficiency is unobtainable, and sets a low value for the combustion temperature.

There is no special condition limiting the compression pressure used in a gas turbine, but the increase in efficiency from high compression pressures is less than in reciprocating engines because the efficiency of centrifugal compressors falls off at high pressures in consequence of the high density of the air in the later stages and the resulting increase in frictional losses. The exhaust pressure will be in excess of atmospheric pressure when the heat of the exhaust gases is utilized in a regenerator or boiler, unless a gas exhauster is employed. As an exhauster acts on the gases after their volume has been diminished by cooling, its use may show an increase in thermal efficiency.

Many modifications of the gas turbine mentioned have been suggested and employed, including the injection of water into the combustion space in conjunction with preheating the compressed air by the exhaust gases. There have been several gas-turbine projects employing an oscillating water column, such as in the Humphrey pump, but these are really water-piston engines.

The calculation of the efficiency of a gas turbine, using variable specific heats, can be carried out most readily by the use of a temperature-entropy chart such as is given by Stodola. In most of the cases considered these calculations were made for some assumed casing temperature and for a series of compressor and turbine efficiencies.

The constant-volume turbine with regeneration gives computed efficiencies as high as 31 per cent, but these high values call for excessive casing temperatures. With water injection and regeneration heating of the compressed charge the maximum efficiency works out as 29.7 per cent. By utilizing the exhaust waste heat in a steam auxiliary, it may reach 39.5 per cent.

The constant-pressure turbine with regenerating heating of the compressed charge gives efficiency closely approximating those of the constant volume cycle, but as the casing temperature limits the permissible combustion temperature, the turbine must operate under a low pressure ratio. As a result of this a low net efficiency is obtained.

A review of the possibilities of the gas turbine does not give much hope for the realization of efficiencies such as would encourage attempts to overcome the many difficulties with which this machine is surrounded. Even with the increase in compressor and turbine efficiencies which may be expected to result from further developments, it seems highly improbable that brake thermal efficiencies as high as 25 per cent could be obtained. The maximum that has been claimed up to the present time is about one-half this quantity, or 13 per cent. This should be compared with brake thermal efficiencies of about 34 per cent with the Still oil-steam engine.

Dr. Lowenstein, General Electric Co., took issue with Professor Marks on the utility of the gas turbine. In experimenting with a combination of Diesel engines and exhaust turbine, he had found that the possibilities of such a combination were attractive. To eliminate trouble with corrosion, quartz blades were used with entire satisfaction.

W. L. R. Emmett recounted experiments he had conducted on gas turbines and was of the opinion that a purely turbine arrangement offered little prospect of having a commercial value. The combination of engine and turbines on the other hand was of advantage, being much used in aeroplane work.

Large Oil Engines

A review of some of the developments in the design of large oil engines was covered by Dr. Charles E. Lucke.

Widening the scopic of utility of large oil engines is mainly a question of reducing weight, and through it a reduction of first cost. Reduction of first cost lowers fixed charges, the chief obstacle the oil engine has in its competition with steam.

Two independent lines of attack have been followed. In the first attempts have been made to secure higher mean effective cylinder pressures, while the second has been directed toward a reduction in the weight of metal used per cubic inch of cylinder volume. This has included the adoption of forged steel in place of cast iron for the cylinder walls and the use of the double acting two-cycle principle. This paper is fully abstracted in *Power*, Dec. 2.

That the logical trend in the design of large oil engines was toward the double-acting type was the belief of Capt. Gatewood of the Shipping Board. He felt that there was entirely too many engine types and stated that the Board would welcome a concerted action on the part of engine builders toward the establishment of a single type for marine purposes.

J. C. Shaw, Cramp and Sons Ship and Engine Building Co., took issue with Dr. Lucke on his general claim that the two-cycle engine was the superior type. He pointed out that of all the motor ships in existence, over 75 per cent were fitted with four-cycle engines, and that even a larger percentage could be applied to recent vessels. The belief was expressed that with 40 per cent of the piston stroke being along the hot exhaust belt, the Worthington design would surely develop faults.

Turbine Nozzle Losses Analyzed

A means not only of measuring the efficiency of turbine nozzles, but also of locating causes, such as eddies or whirls, that make for inefficiency, through the measurements of air flow, was outlined by L. H. Wirt, of the Steam Turbine Department of the General Electric Company, as described in the Dec. 2 issue. Air flow, which was first tried about four years ago for determining flow losses, has proved so beneficial that at present an elaborate testing equipment is operating practically night and day. Blades, nozzles, air-circulating ducts for generators, and passages in general which conduct liquids or gases, may be readily explored by this means.

In a turbine nozzle, for instance, air may be supplied at any desired pressure and so directed as to enter in the same way as steam supplied from a revolving turbine blade. By measuring impact with a movable tube at a point near the nozzle outlet, the efficiency may be calculated. This is derived from the energy that a perfect nozzle should give for the air discharged and also from the energy for the same amount of air per unit of time that is actually realized. The presence of low efficiency areas leads at once to the probability of eddies or whirls in the flow.

Eddies in the steam passage may be traced by coating the passage with neatsfoot oil and graphite. Air is then turned on, which streaks the coating with the same lines as the actual flow. After the air is turned off, liquid plaster of paris is poured in, and the resulting cast represents a permanent record of the lines of flow. By marking arrows as these flow lines indicate, eddies, backward flow, etc., may be readily illustrated. From these, improvements in the design of the passages may be deduced.

Results from testing any element by itself may be misleading, and reference is made to some 11,000 tests of various models, together with proper conditions of air admissions. This is necessary in order to plan out a satisfactory test and to correctly interpret results.

Method Applicable to Other Problems

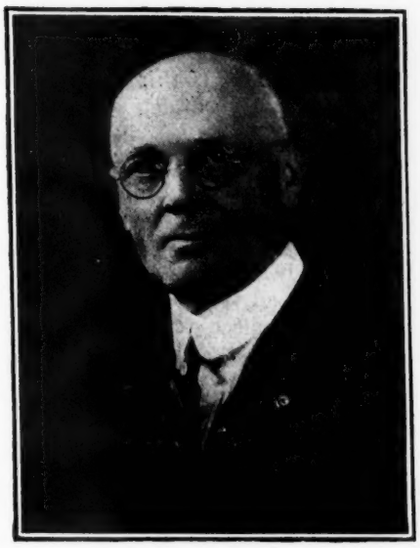
Due credit was given to the author during the discussion that followed for absolute originality in all the accomplishments represented. It was also strongly brought out that the executives of the General Electric Co. showed broad vision in allowing this method to be made public. Benefit would undoubtedly accrue from the fact that such admirable handling of a problem speaks authentically for the thoroughness, talent and skill applied. Also the method here so beautifully outlined may be used as well for other problems, such as transmission of pulverized fuel, grain, etc., by air blast, and in making this method public a decided help is given to the engineering profession. Besides this, the fact that theory and calculations can thus be checked will take much of the element of guesswork from many engineering problems.

This paper showed tests wherein a square corner entailed less loss than a round, which was against practice in the transmission of steam. The author explained that the statement referred only to short, rounded turns, and that with long-radius bends the loss might probably be less than with a square corner. The records of flow directions were found to be reliable inasmuch as they could be easily repeated at any time and an accuracy of 0.2 per cent was usually obtained in the measuring processes.

POWER

BY F. R. LOW

Excerpts from Presidential Address to A. S. M. E.



IT WILL be interesting when some historian, sufficiently removed in point of time to have the right perspective, evaluates the effect of invention and engineering, rather than of conquest and politics, upon the development of this nation.

IT IS within only comparatively recent times that the burden of supporting the race, the drudgery of the struggle for existence, has been transferred to power-operated machinery. Up to the Nineteenth Century man was largely dependent upon the work of his own muscles and those of the animals that he had domesticated, for his sustenance, shelter and transportation. His only help from natural resources was in crude adaptations of water and wind power. Today, power-operated machinery is doing in these United States alone more work than could be performed by all the able-bodied men in the world working like slaves from sunrise to sunset.

It may be interesting, therefore, to take account of the power resources at our command, the increasing rate at which we are drawing upon them; to pass in review the processes by which these resources are converted, to see how nearly we have come to ultimate efficiencies, to glance in the direction of possible improvements and to speculate on other sources of power which research may disclose before our unrenewable supplies of fuel are depleted.

The natural application of running water to the turning of a wheel by weight or impact led to simple reaction types and eventually to the turbine. The possibility of generating considerable amounts of power by the use of this compact prime mover made possible the development of sizeable industries, and the establishment of these industries upon rivers where hydraulic power in the required amounts was producible, was the determining factor in the location of many cities and manufacturing districts.

Power has thus played an important rôle in determining the geographical distribution of industry and the occupation and manner of livelihood of whole sections.

The potential water-power resources of the United States are estimated by the U. S. Geological Survey at, in round numbers, 34,000,000 hp. available 90 per cent of the time and 55,000,000 available 50 per cent of the time.

The total amount of power used, or even of the prime mover capacity installed, is impossible of close estimate. From a survey made jointly by the *Electrical World* and *Power*, there are installed in the mills and factories of the United States, some 34,000,000 hp.; in the central electric stations, 24,600,000 hp. There is some duplication on account of the fact that the industrial-plant figure includes motors, current to drive which is purchased from the central station. The combined installed capacity of prime movers may be guessed at as about 45,000,000 hp.

	Installed Capacity
Central stations and industrial	45,000,000
Electric railways (Jan. 1, 1923)	4,119,000 hp.
Mining (Jan. 1920)	5,147,000 hp.
Stationary non-industrial	4,000,000
Steam railroads	130,000,000
Navigation	5,000,000
Agriculture and traction	200,000,000
Automotive	300,000,000
Total	690,266,000

If these figures are correct, there is installed for each unit of our population prime-mover capacity capable of generating about six horsepower, and at an estimate of 2,000,000 ft.-lb. as a day's work for a man, this would be equivalent to the ability to produce for each man, woman and child of our population if they demanded it, physical service equivalent to that which could be rendered by 142 slaves.

That is what we could have if we had to with the power-producing machinery already at our service; but it is not running all the time or at full load when it does run. Mills run only forty-odd hours a week; the load factor of most central stations is less than 40 per cent. The average generating capacity of automobiles has been taken at 20 horsepower, but they utilize that amount of power only at brief intervals even when running and are parked or in the garage the greater part of the time. Few factories, public buildings, hotels, etc., can tell anywhere nearly how many horsepower-hours they use per year.

It is impossible, therefore, to tell how many horsepower-hours of service are actually produced per year. Only in the case of the public utilities that make power as a commodity, the establishments that buy it by the meter and the comparatively few of the industrial concerns that keep any intelligent record of the amount of power that they produce, can reliable statistics be had. It is evident, however, that assuming a very low use factor for the four hundred odd million horsepower of installed prime movers, the 55,000,000 potential water power of the United States would be vastly inadequate for our present demands even for the 50 per cent of the time that it would be available.

The returns show that the electric public utilities alone will produce this year nearly 80,000,000,000 hp.-hr.

Data available indicate that the electrical production by central stations is increasing at the rate of about 10 per cent yearly. If this rate of increase continues that long, they will have doubled their production in a little over seven years.

We are, then, mainly dependent for our power, and shall be unless and until some other source is discovered, upon our fuel supply.

Fuel is capable of producing heat by reason of the attraction between its atoms, mainly those of carbon and hydrogen, and those of oxygen. A substance is hotter because its molecules move more briskly. As the atoms approach each other under the influence of their mutual attraction, their velocity increases as does the velocity of a body falling toward the earth or the velocity of a planet as it approaches the sun. It is not the clash of these atoms that produces the elevation of temperature, but the velocity and momentum acquired as they fall together and take up their positions, whirling about one another like minute planetary systems, forming the molecules of the resulting substance, the temperature of which depends upon their mass and average velocity; that is to say, upon their average momentum.

Molecular Action in Furnace

In a boiler furnace we have the molecules of the incandescent fuel and the gaseous products of its combustion and the heated furnace walls vibrating at a rate corresponding to something between two and three thousand degrees Fahrenheit. The steel walls of the boiler are composed of molecules, too, vibrating and circulating among one another in regular orbits separated by distances vast as compared with their own diameters. And yet so strong is the attraction between these widely separated molecules that it takes a force of thirty tons to separate as many of them as are exposed when a square inch of section is torn apart.

To these molecules of the steel the momentum of the furnace molecules is communicated and by them passed along to those of the water inside.

When that water was ice, the positions and orbits of its molecules were fixed. Their mutual attraction far exceeded the centrifugal force due to their rotation. But when their velocity had reached that corresponding to 32 degrees, their centrifugal force became so nearly that of their mutual attraction that they could only feebly resist displacement.

In this condition the mass can no longer hold its shape, but takes that of the containing vessel. One can push the molecules aside without effort, as when dipping his finger into the bowl, but some cohesion persists and draws the water into the drop that remains suspended upon the finger when it is withdrawn or into the crystal globe of the dewdrop. As the temperature of the water—that is the velocity of its molecules—is raised in the boiler, their centrifugal force increases until a point is reached when they overcome the combined effect of their attraction for one another and the pressure about them and fly off, like a stone from a sling-shot, into space, producing by their bombardment upon the containing surfaces the effect that we know as pressure.

How many of these molecules do you suppose there are in a cubic foot of steam at 250 lb. pressure? Write down 82,126 and then add twenty ciphers to it and you will have the number pretty nearly.

The carbon and hydrogen of the fuel have been converted into carbon dioxide, or carbonic acid, and into water vapor. A power station burning 100 tons of carbon per hour is pouring enough carbonic acid gas into the atmosphere in that time to cover a plot 100 feet square with a column 630-odd feet in height. Every fire that is burning, every animal that is breathing, is pouring out carbon dioxide, and yet there is no measurable increase in the CO_2 content of the atmosphere.

All that we need to do to get hydrogen or carbon, is to decompose the water or the carbon dioxide; but it takes as much energy to pull those atoms of hydrogen or carbon away from those of oxygen with which they are combined as they generated when they fell together, just as it takes as much energy to raise a weight against the attraction that exists between it and the earth as the weight can generate by falling the same distance.

A cubic inch of carbon in the form of anthracite would, in burning, make enough carbon dioxide to make a bubble about 15 inches in diameter.

It would take as much energy to pull the atoms of carbon and oxygen united in the molecules of that 15-in. bubble of gas apart as it would take to lift a ton weight almost 200 ft. or to run a one-horsepower engine almost 12 minutes.

To separate these elements in the laboratory, we are obliged to resort to the most powerful chemical agents and to conduct the process in vessels composed of the most refractory materials under all the violent manifestations of light and heat; but in the economy of Nature this process is constantly going on, not with the noisy demonstration of prodigious effort, but quietly, in the delicate structure of a green leaf waving in the sunlight.

Absorption of Heat from Sun

The earth's surface absorbs from the sun heat energy equivalent to some 3,900 ft.-lb. per sq.ft. per min. Referred to its cross-section, this means that the earth is absorbing energy from the sun at the rate of over 162 trillion horsepower.

Most of this energy is immediately radiated back to space. A small portion of it is absorbed by vegetation, some in evaporating water and inducing air currents, some in warming surfaces by day to cool off at night, and some in other ways. But it cannot be retained as heat without a rise in the earth's temperature, and there appears to be no large-scale storage of energy going on in other forms as when the coal measures were in process of formation. The energy temporarily stored in the growing tree or grain is reconverted into heat when the combustion of the vegetation takes place either by the slow process of decay, or as fuel in the furnace or food in the animal organism, and in various forms radiated, as is that from wind and water, back into the universe.

The end of the known supply of anthracite is approaching. There are estimated to be, of recoverable fuel of this type in the United States, some eleven billion tons, which at our present rate of consumption will last only about 100 years. It is mostly used for domestic purposes, although the smaller sizes, formerly wasted, are now used for steam making.

Of bituminous coal and lignite there are estimated to still be in the United States some 3½ million million tons, of which about 60 per cent would be recoverable by present methods. We have already used 12 billion tons. At our present rate of consumption the rest would last some 4,000 years. But our rate of consump-

tion has been increasing for the last 25 years at a fairly uniform rate of about 18 million tons yearly. If this rate of increase continues so long, we should use up our visible supply in less than 500 years.

Mr. Julian D. Sears, of the United States Geological Survey, in a paper to be presented at one of the sessions of the meeting, says that the American petroleum industry began in 1859 and it took over 41 years to produce the first billion barrels. The seventh billion was produced in a little over a year and a half. If what now remains could be continuously extracted and consumed at the 1923 rate, it would last less than 11 years. But Doctor Sears asks us not to accept this as a prediction.

As the true coal becomes scarcer and more costly, we shall doubtless learn to use peat, of which we have large supplies.

Control of Power Vital

Power is of such vital and increasing importance that its control would give its possessor a mastery over his fellows and opportunities for tyranny and extortion possessed by no autocrat of any previous empire, visible or invisible, feudal or industrial. The people may well be concerned at any gesture in that direction. Happily, their interest in the water powers has been guarded by the Federal Water Power Act of 1920, which maintained in its integrity and faithfully administered, will retain the title of the nation in these resources, under conditions that offer opportunity to initiative, security to capital and freedom from extortion to the consumer. Control over the distribution and sale of power by public utility corporations is in the hands of public service commissions in most of the states. But an uninterrupted and abundant supply of power cannot be assured to the nation at reasonable rates so long as the fuel from which most of it is made is subject to the uncontrolled manipulation of private interest and the organized will—or won't—of labor.

It is to be regretted that a resource so vital to industry, so essential to its continued existence upon the present and coming planes, should have been permitted to pass out of the control of the people and be subjected to the possibilities of manipulation for private gain. The one crumb of comfort in the report of the recent Coal Commission was its declaration that the mining and distribution of coal is charged with public interest, but there appears to be little probability of the government, as at present constituted, taking any active steps toward their public regulation and control.

Results with Early Engines

How nearly have we come to possible perfection in the process of converting the potential energy of this fuel into power? Mr. George A. Orrok, in a paper presented recently to the society, places the consumption of Savery's engine, built around the year 1600, at 100 pounds of coal per horsepower-hour, and Newcomen's engine of 1750 at about 22. A common figure for the Watt engine of the last quarter of the Eighteenth Century was 10 pounds, although some of the Cornish pumping engines got down to remarkable efficiencies, several records being reported in the first half of the last century of less than 2 pounds of coal per horsepower-hour.

Trials made at Woolwich Dockyard in 1847 and 1848 gave evaporations of eight or ten pounds, averaging about 9.5 for 8 tests.

Professor Unwin reports a boiler test at about the time of the organization of this society, showing an efficiency of 80 per cent.

With all our increased knowledge and refinements we have been able to get this up to around 90 per cent and this only in exceptional cases in our best-designed and most skillfully operated plants. The average for the smaller and less expertly handled plants is below 60.

There is evidently not much opportunity for improvement in the maximum efficiency, but a great opportunity for improvement in the general efficiency. This can be effected by greater attention to the design and operation of plants that are able to make their power cheaper than they can buy it, and by abandoning those that cannot justify their continued operation in favor of power from an efficient central supply.

This step should not be taken, however, without giving full weight to the value of the exhaust or extracted steam from one's own engines or turbines for heating and manufacturing processes. It takes only about 50 more heat units to make a pound of steam at 250 lb. than at atmospheric pressure, and after it has done its work in the engine it will have over one thousand heat units left in it, the difference between which and the temperature at which it is desired to use it will be available for heating and process work.

A station developing 100,000 kw. at 15 lb. of steam per kilowatt-hour will discharge into the river over a billion and a half B.t.u. per hour, the equivalent of which in steam for heating or manufacturing processes it would take over 85 tons of coal to make.

Our present effort toward reduction in fuel consumption is in the direction of increased initial pressures. We have already gone about as far in initial temperature as the materials at present available will stand.

Lowest Attainable Steam Consumption

The lowest steam consumption attainable by any combination of suggested processes such as bleeding, reheating, etc., would be with 1,500 lb. pressure, 750 deg. initial temperature, 29 in. vacuum, 85 per cent efficiency, about 4 lb. of steam per horsepower-hour. This steam including the heating during isothermal expansion requires about 1,400 B.t.u. per lb. and a boiler of 85 per cent efficiency would require a little over one-half pound of 12,000 B.t.u. coal to evaporate and reheat the 4 lb. of it required to produce a horsepower under these conditions.

Just as the amount of power that can be gotten out of a given quantity of water depends upon the height through which it can be made to fall, so the amount of power that can be gotten out of a given quantity of heat depends upon the range of temperature through which it can be made to drop. This lower limit is set for the steam engine by the temperature of the condensing water, the upper limit by the temperature that the available materials will stand and the pressure that increase of temperature generates in the medium.

Recent researches in electrochemistry and molecular physics have been productive of marvelous results and are full of suggestion of future possibilities. The time is not inconceivable when the tools of our present wasteful processes of power generation will be as archaic as the turbine of Hero and the engine of Papin. For the present we must use our best endeavors along established and developing lines to make the most and best efficient use of our diminishing visible resources in the face of the rapidly growing demand.

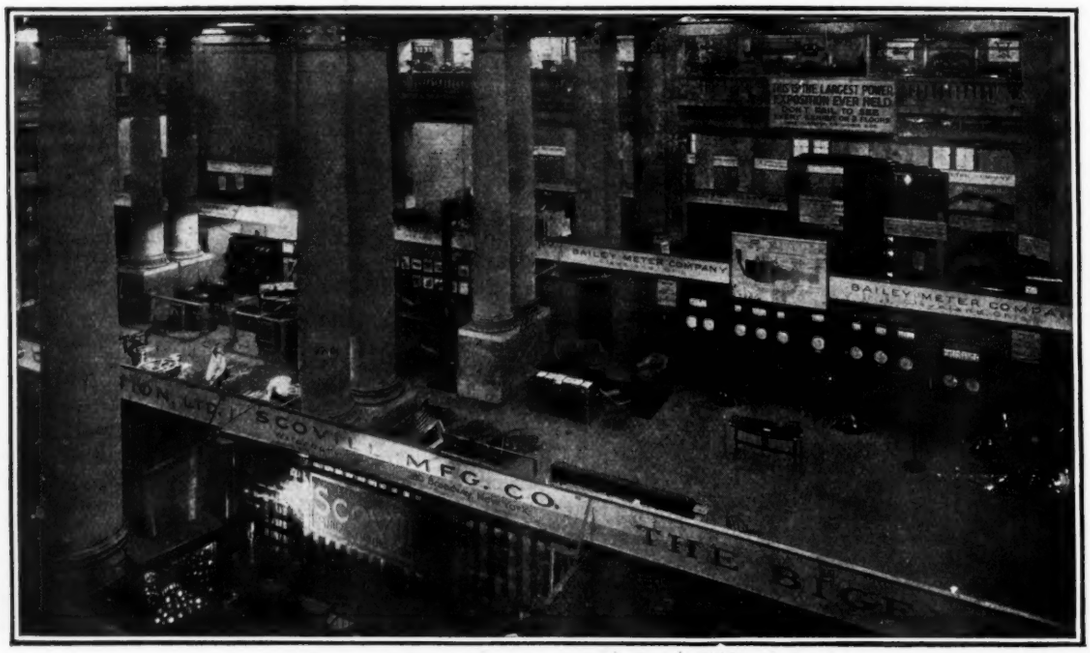


Fig. 1—View of Power Show from mezzanine

Third Power Show Bigger and Better

Nearly Fifty per Cent Larger Than Last Year's Show and Three Times the Size of That of 1922, This Year's Power Show Stands Out as a Great National Institution Reflecting Remarkable Growth in the Art of Power Generation

THE power show of 1922, or as it was more formally termed "The First National Exposition of Power and Mechanical Engineering" was nothing to be ashamed of. To cover the high spots of the 120 exhibits, was a good day's work for any engineer. The exhibits were well displayed and calculated both to interest and instruct. Nearly 48,000 visitors came away with a wider practical knowledge of their fields.

Yet everything is comparative in this world. The first power show was only a taste of what was to come. In 1923 the number of exhibitors had jumped from 120 to 260, overflowing the main floor of the Grand Central Palace, New York, and using most of the second. The number of visitors increased to 62,000. This year there are about 380 exhibitors, requiring all of two and part of a third floor.

This substantial increase in the space requirements can only mean that the value of the power show as an educational force has been demonstrated. The conviction that this is the case is deepened by the presence of a few prominent concerns who did not avail themselves of previous shows.

Definite figures as to attendance are not available as this issue goes to press, but the flood of ticket requests promises a substantial increase in this respect also.

So far, the main emphasis has been laid on size, but a picture of this year's power show as last year's two-volume edition with a third volume tacked on would give no idea of its true significance as a mirror of engineering progress. At the present rate of engineering advance even a single year brings its flood of new and improved apparatus reflected in the exhibits.

A good example is found in valves for pressures around 600 lb. and temperatures ranging up from 750 deg. F. Last year only a few such were exhibited—and these mainly as something sensationally new. This year the number, size and variety of high-pressure valves was an impressive feature of the power show. One large valve on exhibition will immediately be placed in oil-still service at 500 to 600 lb. pressure and 1,000 deg. F. temperature. Another was designed for service at 1,200 deg. The trend toward much higher pressures was also reflected in exhibits of high-pressure traps and other draining devices, feed-water regulators, piping, etc.

In every line progress was shown. The refractory manufacturers displayed new types of furnace-wall construction and improved refractories to meet more strenuous operating conditions. Power-plant instruments showed a marked development, particularly apparatus for gas analysis and combustion control.

Motor-operated valves, already well represented last year, were present in increased variety with many improved features both in the valve unit itself and in methods of control. Much more attention was given to such relatively new devices as air preheaters and generator air coolers. Distinct progress in the design and construction of such auxiliaries as evaporators, pumps, heaters, etc., was manifest.

Aside from the quality and variety of the apparatus exhibited, the power show of 1924 was significant in its revelation of the change that has taken place in the selling personnel of the industry. While courtesy and good fellowship are as valuable assets as ever, the glad hand is no longer depended upon for sales. Engineers are demanding facts as a basis of choice, and through-

out the industry manufacturers have found it necessary to employ as salesmen engineers prepared to furnish these facts. Such sales engineers, in attendance at almost every booth, were ready and able to demonstrate the essential points of their products in a concise and understandable manner.

More use than formerly was made of working models, often with glass sides to show internal operation. The eye being quicker than the ear to size up a principle

Fig. 2—View looking down the center aisle

of operation, this increased the value of the show to visitor and exhibitor alike. Interest was also aroused by the greater number of full size sections of boilers, economizers, etc. A number of small prime movers were exhibited, but one of the greatest opportunities for improvement lies in the direction of securing more and larger prime movers for future power shows.

The pages that follow are intended to convey to the reader unable to attend the power show in person some of the impressions he would have gained had he been present. The enormous extent of the exhibits makes it out of the question to attempt even a running description of the exhibition, booth by booth. The alternative has been to pick out for brief mention or description typical new developments and marked improvements in existing apparatus. The rigid application of this policy makes it necessary to pass without mention a large number of excellent exhibits but, taking into account the limitations of space and reader's time, such an outline would seem best to meet the needs of the average subscriber.

A list of exhibitors, with a brief outline of their principal products, appeared in the December 2 issue. In that issue mention was also made of certain exhibits of particular interest, regarding which advance information had been sent in by the manufacturers. Such are not mentioned again in the present article, even where they would otherwise come under the classification of strictly new or improved apparatus.

One of the most extensive exhibits at the Show was that of the Combustion Engineering Corp. Here a four-tube section of the fin-type furnace wall was shown set as it would actually be placed in a furnace. This is a comparatively recent development and was first tried out on a stoker-fired furnace at the Hell Gate Station, as described in the Sept. 2 issue. Two retorts of the Frederick underfeed stoker and a duplex pulverized-coal feeder were in operation. A section of a "C E C" air preheater, a "Lopulco" pulverized-coal burner and a portion of hollow furnace wall were also shown.

The Fuller-Lehigh Co. exhibited a complete line of pulverized-coal equipment, including pulverizers, vertical and horizontal burners, triplex feeders, direct-connected motor-driven feeders, and a 4-in. pulverized-coal transport pump. In addition, a 1-in. model of the Fuller-Kinyon pump was in operation pumping pulverized talc through a ¾-in. discharge line. The pipe was equipped with distributing valves and clearly demonstrated the flexibility of handling pulverized coal in this manner. A standard electric-pneumatically operated distributing valve together with bin signals and switchboard containing the usual push buttons and pilot lamps, were also shown.

The Furnace Engineering Co. exhibited a unit pulverizer of 6,000 lb. per hr. capacity operating at about quarter speed. Recent improvements in this pulverizer include the placing of a conical shaped coal crusher ahead of the feeder. This crusher reduces the coal to a more or less uniform size and tends to assist in producing a uniform flow of finished product from the pulverizer to the furnace. Other unit-type pulverizers were those of the Aero and Erie City Iron Works.

Oil-burning equipment received a great deal of attention, many types being shown in position on a boiler front. Others were in operation as mentioned in the previous issue. Several oil-pumping and heating units were included, as were burners for firing domestic furnaces.

Several mechanical stokers were in operation, including two retorts of the Riley underfeed super-stoker with reciprocating side bar and rocking drop. A Harrington traveling-grate stoker suitable for installation under a 3,000-sq.ft. boiler was in operation. The traveling-grate

Fig. 3—View along one of the outer aisles

section being partly disassembled to show constructional features. A multiple-retort underfeed stoker was also shown by the Detroit Stoker Co.

The Flynn & Emerich Co., of Baltimore, demonstrated two units of the Huber mechanical stokers, complete with feeding hopper and ignition arch. In this the feeding plunger and the grate bars are operated independently by hydraulic cylinders. Hopper-feed hand stokers of the Marion Machine Foundry & Supply Co. and the Perfection Grate & Supply Co. were exhibited.

As gurgling and other noises that frequently occur

in steam-heating systems are familiar to most of us, the exhibit of Warren Webster & Co. was of exceptional interest. This company has conducted extensive investigations into the cause for these noises under different operating conditions. The exhibit at the Power Show illustrated the apparatus used in the research laboratory to visualize the operating conditions in the heating systems. The apparatus consists of a large panel board on which is mounted a complete layout of vacuum system of steam heating in which most of the usual piping has been replaced with glass tubing. Air is made to flow through the system to produce the same visual mechanical effects as the steam. In this way the action taking place in the heating system is shown and is particularly instructive. Further description of this system will be given in an early issue of *Power*.

A wide variety of boiler room instruments were on display, some new, others remodeled to give more effective service or to give sufficiently accurate results at a lower cost, and still others varying in the mounting, a noticeable feature being the general adoption by nearly all builders of the flush type meter. During the year many of the manufacturers had added to their respective lines, so that an instrument or meter for almost every conceivable function was to be seen at the Show. A summary of the more recent developments on exhibit follows:

American Schaeffer & Budenberg Corp. of Brooklyn, N. Y., had on display panels with a complete line of the new Columbia flush-front gages and the multiple-draft gages, made in single, double and triple units.

Bailey Meter Co., of Cleveland, in addition to its new flush front meters, showed the new temperature recorder for high-pressure service, the feature being a bulb attached to the exterior wall of the pipe instead of being inserted in the usual way. Other features were a pneumatic tachometer compensated for barometer and temperature and the large power-plant chart showing

Fig. 4—Looking down the east aisle of the mezzanine

the application of the various meters and gages to which previous reference has been made.

The Bristol Co., of Waterbury, Conn., featured the new indicating high-resistance pyrometer, a line of long distance transmitting and receiving gages and a new fast-moving voltmeter to show the minute fluctuations when a change in voltage occurs. Only at such times does the chart move and the speed of movement then gives a wide-open curve.

The Brown Instrument Co., of Philadelphia, showed a variety of indicating and recording, signaling and control thermometers and pyrometers. For the signaling, red, white and green lights flash the indications. Flush type instruments were in evidence, also the electric CO_2 meter given previous mention and indicating and recording tachometers graduated in feet per hour to give stoker travel.

In the Builders Iron Foundry display was a new venturi meter for the refrigerating plant and suitable for the measurement of ammonia. An oil seal is placed in

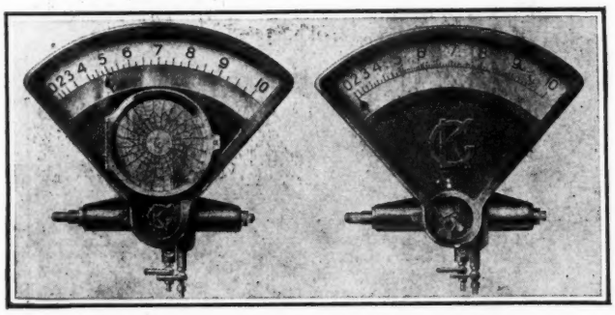


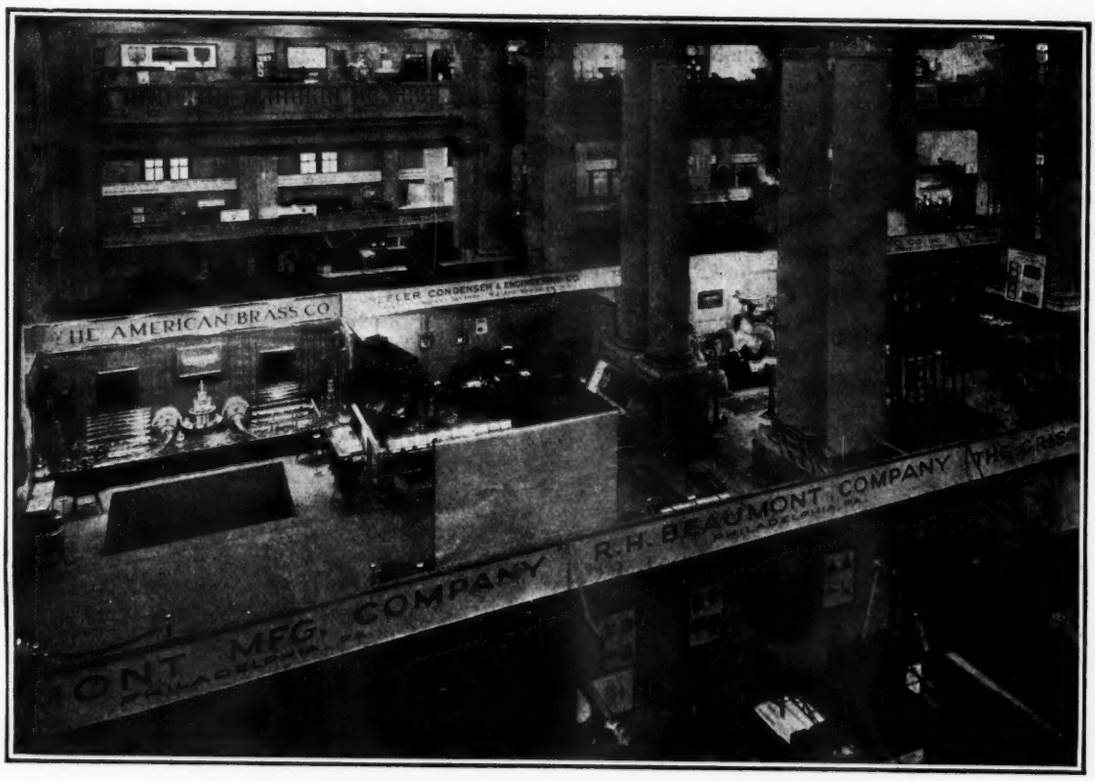
Fig. 5—New type G K Venturi meter

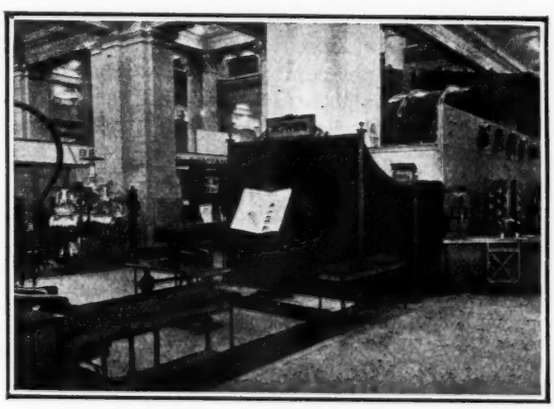
each pressure line between the venturi tube and the instrument to keep the ammonia from entering the latter. The tube is of all-iron construction, emergency check balls are provided at the seals and a small supercooler precedes the tube to prevent the formation of vapor at the throat of the tube. Another innovation was the new G K venturi meter, shown in Fig. 5, of the indicating or indicating and recording types primarily designed for the measurement of steam, but also usable for boiler feed, hot or cold water, as differential gages where the cost of a more complete instrument would not be warranted. In operation the two pressures from the primary device, venturi tube, nozzle or orifice plate, act upon opposite sides of a flexible diaphragm held in position by two springs in tension in the lower part of the instrument. The diaphragm is moved in proportion to the difference in the two pressures, inlet and throat, and this movement is transmitted directly to the indicator dial hand and pen arm. Full capacity may be exceeded with injuring the meter.

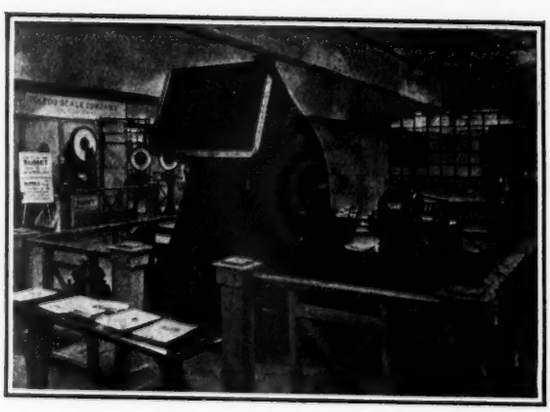
Cambridge Instrument Co., of Ossining, N. Y., showed a line of CO_2 and temperature measuring instruments in new metal cases with 40-day charts designed for the office or the plant, 12- and 35-point distance thermometers of double-scale indicating type, and, of particular interest, a new disappearing filament pyrometer that has met with great success in England. A filament lamp illuminated by a 2-volt cell is used. The instrument is sighted on the furnace whose temperature is to be measured and the rheostat adjusted until the filament merges with the background, when the temperature is read on the scale above. The pyrometer is a multi-range instrument that can be calibrated up to 4,000 deg. F. Its advantages are rapidity of measurement, portability and simplicity of operation.

A new feature appearing on the Cochrane steam flow meter was an integrator operated by clockwork and throwing no load upon the mechanism of the meter balance. As a special display this integrating mechanism was mounted on a base below the meter in conjunction with an exhibition flow meter showing the principles of operation.

Random Views of the Power Show of 1924







Charles Cory & Sons, Inc., featured the Cory-Recony standardized unit system for valve control, made in five different types for all sizes of valves with either the bull's eye or annunciator control station. The visible signal system for load indication and turbine order signals, the Robinson interlock designed to protect men from opening disconnecting switches under load, and the audi-visible annunciator were other products on display.

Crosby Steam Gage & Valve Co. had a full display of Nickoly (monel metal alloy) globe and gate valves for high-pressure steam and heavy steel valves for 600 lb. pressure in addition to a variety of flush-type gages.

In an attractive display of draft gages, Lewis M. Ellison had a furnace control panel consisting of differential draft gage, blast gage and a fuel rate indicator. The instrument last named is a chronometric tachometer attached to the stoker shaft, which in conjunction with a control chart calibrated for a specific boiler serves to corelate air and fuel rates and windbox pressure. Another new attraction was the Ellison-Leach gas analyzer made of Monel metal and Pyrex glass to give strength, resistance to corrosion and clearness. The instrument automatically measures its own sample and the absorption chamber is in static balance. Specifically designed for ruggedness, accessibility and simplicity of operation, it is made in 50 c.c. size for stationary work and 25 c.c. for the traveling engineer.

Federal Gauge Co., of Chicago, featured for refrigerating work an instrument panel of flanged gages, completely wired and equipped with mercoid switches. Similar panels are made up for steam, air and oil burning equipment. Also a new mercoid float switch was on display.

Fig. 6—Republic wall type indicating pyrometer

Paul B. Huyette Co. showed the Hays CO_2 recorder simplified and rearranged to better meet all boiler room requirements, the new Hays line of mechanical draft gages and Reliance water columns of forged steel for 500 lb. pressure.

In addition to its own line of Ashcroft gages, Hancock valves and Consolidated safety valves for pressures up to 1,200 lb., Manning, Maxwell & Moore showed the new Reeves variable-speed individual drive consisting of a constant high-speed motor and the variable-speed transmission equipped for regulation by handwheel, sprocket and chain, electric or manual remote control.

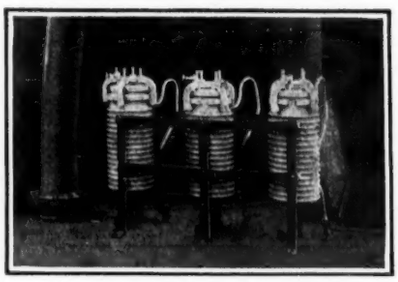


Fig. 7—Typical installation of filtrators

or automatic regulation. A feature of the drive is a new steel line V-belt using a Ramsey silent chain for the body. This replaces the rubber belt body with wood block sections and leather tips formerly used.

Moto Meter Co., Inc., of Long Island City, exhibited a new line of Motoco dial thermometers for industrial application. The operating mechanism consists of a Bourdon spring filled with alcohol having direct connection with the pointer. Other specialties were a combination indoor and outdoor thermometer and a thermometer visible from the street adapted for the small service transformer.

Tinius Olsen Testing Machine Co., of Philadelphia, had an interesting display of special testing machines featured by a new pendulum operating stand for studying the hardness of materials, a strain gage for studying the stresses in built-up structures and a machine to give the static and dynamic balance of rotating parts.

Payne Dean, Ltd., of New York, had an attractive exhibit, the new feature being a centralized control board showing by means of red and blue lights at the proper locations in a mimic piping layout, the valve operation in the steam lines from the boilers to the turbines. Other attractions were a switchboard instrument to record the direction of the wind and a boiler room panel having gages with 40-in. dials.

Ranarex CO_2 indicators and recorders featured the display of the Permutit Co. of New York. This is a new type of meter based on the fact that the weight of CO_2 is about 50 per cent greater than that of the main constituents usually present in flue gases. Thus the weight of the flue gas increases in proportion to the CO_2 content, so that a comparison with an equal quantity of air determines the amount of CO_2 in the gas. As the instrument gives a continuous reading with a minimum time lag, it enables the fireman to observe the immediate effect of any change in combustion conditions. Principles of operation and details of construction will be presented in a later issue.

Republic Flow Meters Co., of Chicago, had a comprehensive exhibit showing the company products. Among them were a number of new meters such as a gas meter of float type to determine the flow into any specific section of the city and at the same time give

the pressure in the line, an electrically-operated water level indicator and recorder, a new meter to determine the volume of the coal burned, a complete line of indicating and recording pyrometers, and perhaps most important of all a complete set of instruments, indicating, integrating and graphic recording, that are not affected by a 20 per cent change in voltage either way. The application is similar to the Freeman integrator given mention in these columns some time ago.

A special type of transformer designed to keep the transformer oil free from air has recently been placed on the market. For dehydrating such oil the De Laval Separator Co. exhibited a new centrifugal dehydrator

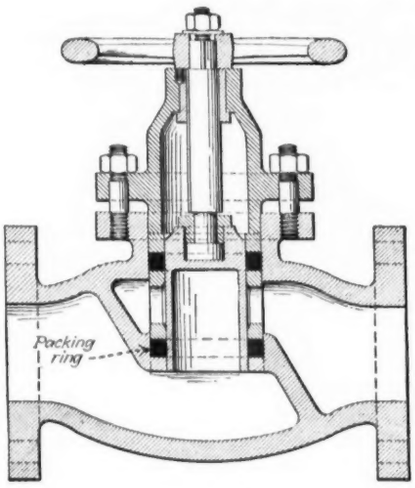


Fig. 8—Klinger piston-type valve

so designed that no air can get into the oil at any point. Another exhibit at the same booth was the Funk oil-sludging apparatus. This consists essentially of a baffled tank provided with thermometers, gages, etc. Measured volumes of oil and water are inserted and the mixture raised to 212 deg. F. Metered air is supplied and the mixture circulated for a definite period. By removing the oil and "centrifuging" it, a direct determination of the sludge may be made. This test, it is claimed, shows the suitability of oils for turbine service.

A most interesting record of engineering progress was presented in pictures, models and historic originals by the National Museum of Engineering and Industry, whose exhibit covered a large space on the second floor. An illuminated model of the Hell Gate station showed the turbines, boilers and auxiliaries within. A fine series of symbolic paintings depicted the development of the gas industry. The development of the typewriter, telephone, electrical appliances, locomotion, conveying etc. was graphically depicted.

An historical exhibition of machine tools gotten up by Prof. J. W. Roe of New York University and Guy Hubbard of Windsor, Vt., was shown as part of the National Museum Exhibition. Among the exhibits was the first measuring machine (1878, Brown & Sharpe Manufacturing Co.), one of the first milling machines etc.

Among the companies exhibiting sections of furnace walls, arches, refractory materials, etc., were the American Arch Co., Inc., Bernitz Furnace Appliance Co., the Carborundum Co., M. H. Detrick Co., Drake Non-Clinkering Furnace Block Co., Green Fire Brick Co., M. A. Hofft Co., Jointless Fire Brick Co., Keystone Refractories Co., King Refractories Co., Inc., Liptak Fire Brick Arch Co., McLeod & Henry Co., Mack Engineering and Supply Co., Maphite Sales Corp., Norton Co., Queens Run Refractories Co., Inc., Quigley Furnace Specialties Co., Waite & Davey Co.

In addition to standard lines several new products and applications were on display. M. H. Detrick Co., Inc., showed a new sectionally supported hollow furnace wall. The surface immediately exposed to the fire is built in sections, each of which is independently supported by cast-iron hanger bars which in turn are supported on the outside steel work. The arrangement permits any section to be repaired without providing temporary support for the sections above.

Of particular interest because of recent activity in water-cooled furnace walls was a new silicon-carbide block exhibited by the Drake Non-Clinkering Block Co. This was a small solid block molded to fill the spaces between the tubes of a water wall.

Two new developments in air-cooled furnace walls were exhibited by the Liptak Fire Brick Arch Co. In one of these the inner wall was bonded to the outer at intervals by a layer of interlocking bonding tile. This gives a slip joint for vertical expansion and does away with extremely long bonding brick, which have a tendency to shear off.

Pointed lining bricks projecting forward to give backing to the (inner) veneer wall of furnace blocks were a new feature of an air-cooled wall exhibited by McLeod & Henry Co.

The Quigley Furnace Specialties Co. showed a new type of refractory cement sprayer. This has a large vertical cast-iron cylinder with a loose plunger. Compressed air admitted below the plunger forces the "aggregate" out into a "Y" branch whence it is carried to the spray nozzle by a separate stream of compressed air. This apparatus was described under the name "Acme Plastic Sprayer" in the Nov. 4 issue of *Power*.

The same company exhibited a furnace wall in which the crushed old furnace linings bonded with Hytempite were backed up by heavy expanded metal tied to the outside wall by through bolts.

Valves and Fittings

As a power plant at 600 lb. pressure has been placed in operation, and another at 1,200 lb. is now almost ready to start, as illustrating advances in practice since the last Power Show, it is only to be expected that exhibits should reflect progress, especially regarding valves, piping and fittings, which represent to a large extent both the transportation and control of power. The Chapman Valve Co. in addition to exhibiting a line of valves for 750-deg. steam service showed a 6-in. 600 lb. 1,000 deg. F. valve which was to be placed in oil-refinery service at the conclusion of the Power Show. An improved control allows the operation from two different stations with indicating lights to show the actual valve positions. A hand release at the valve changes from electrical to hand control with suitable indications at the operating stations.

An exhibit by the Walworth Manufacturing Co. contained a large-scale chart of tests on steel at various temperatures and a record by X-ray analysis of good and bad steel castings. As a result of electric furnace application in which an experience of ten years is drawn upon, it appears that formulas or physical tests are not sufficient to insure high-grade castings, but that foundry practice is an equally important item.

New lines of valves and fittings were exhibited, and a 30-in. turbine atmospheric relief valve together with bleeder valves and accesories also for turbines were presented by Atwood & Morrill. Forged steel valves for service up to an extreme of 850 lb. 1,200 deg. F. were illustrated by the Columbus Machine Co. A new line of high-pressure globe valves of ¾-in. and up, of solid flanged construction has been developed by the Consolidated Safety Valve Co. The equipment for a 400-lb. boiler header was shown by the Crane Co., containing relief, stop and check valves, etc., such as would be used in present practice.

Pressure-regulating valves, traps and specialties suited to new conditions were exhibited by Walter S. Dickson & Co. A new product of the Edward Valve & Manufacturing Co. is a 2-in. forged steel plug-type globe valve for severe service, such as pressures of 500 to 11,000 lb. A new 450-lb. blowoff valve, shown by the Everlasting Valve Co., was of cast-steel construction for high pressures. The Farnsworth Co. showed improved steam traps. A line of forged steel fittings showing tees and crossovers for high pressure was exhibited by the Hydraulic Press Manufacturing Co.

Valves connected by glass tubes showed the effect of circulation, in the booth of Jenkins Bros. A recent development of high-pressure joints is the bolted tongue-and-groove type of the M. W. Kellogg Co. It has been difficult to upset the end of a pipe sufficiently for machining tongue-and-groove connections. This has been overcome by making instead forged steel sleeves which may easily be machined for both the joint and the swivel collars, and then forged welding this to the pipe itself.

A line of seatless service valves appears in Fig. 8, exhibited by the Klingerit, Inc. The fluid must pass through ports, under a sleeve which may be lifted clear of the ports. Packing rings on the movable sleeve make stem packing unnecessary. A 16-in. motor-operated 400-lb. gate valve was shown by the Lukenheimer Co. as a sample of its new line that may be furnished for temperatures as high as 900 deg. F. The Merco Nordstrom Valve Co. has high-pressure plug blowoff valves up to 10 in. New valves were also displayed by the Mueller Co., Inc. The Midwest Piping & Supply Co. has developed a special joint for high pressures and temperatures in which a globe seat is utilized without a gasket.

A new type of electric valve control which utilizes a magnetic clutch could be inspected in the booth of the Pittsburgh Valve, Foundry & Construction Co. Disconnection of the driving power is positively and accurately controlled so that drifting after opening the electric circuit, is avoided and pressure may be applied through the complete closing cycle. Interruption of the electric circuit automatically releases the clutch, making hand operation instantaneously applicable. A new line of forged steel non-return, gate valves, etc., has been developed by the William Powell Co. New motor-operated valves were exhibited by the Research Engineering Corp. Recent developments of the Sarco Co., Inc., include a temperature-operated steam trap made of helical tubing for extreme conditions and also a new type of trap for discharging the moisture from coils which condense air, etc.

Toggle-joint check valves, 8-in. triple-duty stop and check, and non-scraping gate valves, have been developed by the Schutte & Koerting Co. An improved sludge pump shown by the Techno Service Corp., utilizes ball valves wherein flexible rubber seats that may be reversed, support the balls. By removing two nuts the suction valve may be opened for inspection. Steam traps for heating systems were exhibited by the Vasil Steam Systems Co. Henry Vogt Machine Co. presented forged steel valves developed for refinery service for use at elevated temperatures and pressures.

Opposed Flow Blowoff Valve

A new development in seatless blowoff valves representing a balanced type free from shock of the discharged steam or water was introduced by the Yarnall-Waring Co. This is similar to this company's previous seatless valve except that the blowoff sleeve contains two openings instead of one. These openings are opposite each other so that at the moment of blowing off, the entering jets oppose each other and eliminate the shock on the discharge sleeve. A new type of trap utilized ball-seated valves in place of the usual needle valve. Valves for high pressures have been developed by the Foster Engineering Co. in new types and a flexible joint for hose, etc., was exhibited wherein a packed ball-seated joint is kept tight by means of spring pressure against the packing.

Corliss-type valves are applied to steam traps by W. B. Conner, Inc. The latest improvement relates to interior parts of the valve, which insures pressure against the seat due to the weight of the ball when the trap is discharged. A new trap just put out by the Swartwout Co., places all the working parts outside of the trap with the exception of the ball itself. The parts are so standardized that adjustments by the engineer are practically eliminated.

What goes on in throttling with a protected valve seat was shown in the booth of the Homestead Valve Manufacturing Co. The valves were sectional and worked against glass partitions so that the throttling action with water passing through could be readily seen.

The Liberty Electric Corp. showed a special type of control for valves. The Ballwood Co. showed fabricated square-cornered pipe suitable for Van Stone joints, as well as reducing sections from 6 and 10 in. also fitted with Van Stone joints.

Brass products, condenser tubes, wire, etc., are standardized so that little development in the character of the product is to be expected. What these products may do in the engineering world was illustrated in the booth of the Bridgeport Brass Co., where models built to scale were in active operation. The exhibits of the Scovill Manufacturing Co. and the American Brass Co. showed the extent to which their products are at present utilized.

Preheaters were exhibited by Connery & Co., the Buffalo Forge Co. and James Howden & Co. of America. The types were described in the Dec. 2 issue. An unusually large breeching with an expansion stiffener joint was erected in the Connery booth.

In heating and ventilating apparatus many types of air heaters wherein heat from steam is absorbed and delivered by circulating air were shown.

A gasket for high pressures and temperatures has been developed by the Metallo Gasket Co., consisting of two corrugated steel plates separated by asbestos.

Monel Metal Included in Many Exhibits

The International Nickel Co. illustrated the varied uses for monel metal, which include pump plungers made by shrinking monel sleeves over pipe. Weldless

rolled rings are produced from a doughnut-shaped ring of monel metal which, when finished, gives strength much superior to castings and which may be manufactured with a high degree of precision.

In line with the high steam pressures now coming into general use, the S. C. Regulator Co. exhibited a feed water regulator and drainage control recently developed for 650 lb. pressure. A new excess-pressure regulator for motor-driven pumps was also shown.

The Engineer Co., had on exhibition several boiler-tube sections showing vertical and horizontal baffles, also a drum covering that can be molded in place to protect the drums of water-tube boilers. In addition, this company showed a new type of electrically-operated combustion control, consisting of a master regulator for controlling the speed of one or more forced-draft fans, a regulator for adjusting the stoker speed in direct proportion to the quantity of air supplied to the fuel bed and a regulator for balancing the furnace pressure by operating the boiler damper. A complete description of this control will be given in a later issue.

Hollow balls for use in pumps, compressors, check valves, etc. were displayed by the Hollow Ball Co. of Baltimore. These balls weigh 60 per cent less than solid balls of equal diameter and are made of any standard metal, such as brass, steel, aluminum, etc.

Compressorless Diesel Engine

Among the prime movers exhibited were three gasoline engines made by the Climax Engineering Co. and a "Benz" compressorless Diesel engine shown by the Stewart-Sayers Co. Although the latter is of only 10 hp., it delivers a brake horsepower on 0.46 lb. of oil.

The R. H. Beaumont Co. in addition to its usual line of ash and coal handling equipment exhibited a power-operated ash gate. This is accomplished by a piston, actuated by air, water or steam.

An extensive exhibit was that of the Bethlehem Shipbuilding Corp. Here a complete oil burning, heating and pumping equipment was on display. In addition, different types of reciprocating and turbine-driven feed pumps were shown. The Superheater Co. displayed two complete four-loop sections of the "Elesco" superheater.

Among the specialties of the Mason Regulator Co. was a new type of V-port, high-lift, balanced valve for controlling the steam supply to fan engines or other auxiliaries. A regulator, adaptable to a number of uses, such as, controlling temperature, humidity, vacuum, etc., was shown for the first time by the Arca Regulator Inc. This was described in the Aug. 5 issue.

The model of a 5,000-kw. condenser attached to a turbine, complete with air pump, relief valve, etc., appeared in the booth of the Wheeler Condenser & Engineering Co., as well as products formerly of the Alberger Pump and Condenser Co. concern they have recently acquired. A new development in radojet pumps has just been placed on the market by the C. H. Wheeler Co., which is a single-stage pump capable of producing a high vacuum.

In addition to its line of steam pumps, the Warren Steam Pump Co. exhibited a hydraulically balanced centrifugal pump for high-pressure boiler-feed service. This pump, which has been recently developed is made in several sizes and in 2, 4 and 6 stage and is built for pressures up to 550 lb. The impellers are grouped in pairs and are opposed to each other. This arrangement tends to practically eliminate excessive end thrust. The Fairbanks Morse Co. showed a line of single-stage motor driven centrifugal pumps fitted with ball bearings.

The Blackburn-Smith Corp. in addition to its line of strainers and oil extractors exhibited a centrifugal pump in operation equipped with the Apco centrifugal pump primer. This primer was described in *Power* April 29.

A recent development in the line of equipment for separating moisture and impurities from the steam before leaving the boilers was shown by the Centrifix Corp. of Cleveland. This device, which takes the place of the regular dry pipe inside the boiler drums consists of a shell fitted with a series of blades through which the steam passes tangentially and takes on a whirling motion. This causes the impurities to separate from the steam and be carried forward, being finally discharged through a tangential opening at the top of the shell.

The Filtrators Co. of New York exhibited for the first time its apparatus for treating boiler water, which consists essentially of a cast-iron ribbed cylinder containing a perforated shell which is charged with linseed in prescribed quantities.

The cylinder is connected to the steam and water space of the boiler. A portion of the steam enters the filtrator and there condenses, extracting from the linseed the mucilage which forms with it a colloidial emulsion. This is allowed to pass continuously into the boiler, where it mixes with the water, films the solids as they are precipitated and prevents their adherence to each other or to the surfaces of the boiler. A typical installation of this filtrator is shown in Fig. 7. A more complete description of this will be given in an early issue.

Sarco Co. of New York in a full exhibit of standard products showed a new high-pressure expansion trap of bellows type with conical seat for drip service.

Simplex Valve & Meter Co. showed an improved Simplex boiler feed meter of the venturi switchboard type in which the indicating dial had been brought forward in plain view and other improvements made as in the adjustment of the register and simplified method of calibration.

D. H. Skeen & Co., of Chicago, showed a section of the Mercon regulator and prints of the reducing valve and constant boiler flow regulator. These were exhibited in the booth of the W. K. Sowdon Co., which also contained an Eclipse smoke indicator and a Williams steel water column for 600 lb. pressure measuring 6 ft. high and 10 in. diameter.

C. J. Tagliabue Mfg. Co., of Brooklyn, showed among a large exhibit of standard products the new style Mono electrically operated flue gas recorder.

Of the Taylor Instrument Co. display the new feature was a barometric type mercury column vacuum gage intended primarily as a master check instrument on official tests. As an indication of the possibilities, the the gage has a vernier reading to thousandths of an inch.

Uehling Instrument Co. had a complete working exhibit of the new Apex CO_2 recorder, a simplified inexpensive device adapted for the smaller plant. It consists of the CO_2 meter and the gage proper, a manometer containing a glass tube filled with colored liquid, which changes its level according to the pneumatic pressure applied to it, giving a corresponding indication on the scale. The change in pressure is effected by absorbing the CO_2 in the flue gases during their

passage through the meter, thus reducing the pressure and operating the indicator. More complete details are to be given later.

A number of new things were to be found in the exhibit of the Foxboro Co., Inc., such as a four-pen pressure gage for bleeder heaters, a complete set-up of orifice-type steam flow meters reading in pounds and hand-operated liquid level gages, the latter measuring the pressure necessary to force out air, by means of a plunger, against the head in the container in which the level is to be established.

With its display of cast-iron, cast-steel and pop safety valves for high pressures, the Ashton Valve Co. showed a master pilot pressure gage with double dials, the new feature being a convenient adjustment for calibration.

General Electric Co. had a number of attractive exhibits of recent development, such as a 5-kw. 3-phase electric boiler in operation. The output was being measured by the company's induction type electric flow meter and a control panel fully equipped with instruments and push-and-pull control was provided. Another attraction was the new cooler for generator air, made up of copper tubes and corrugated radiating surfaces, through which boiler feed is circulated. In the display there was a variable speed alternating-current 220-volt motor for stoker drive with a speed range from 400 to 1,250 r.p.m., pulling 10 to 50 hp. The motor is of the brush-shifting type with special windings on the rotor and stator, slip rings and automatic push-button control. The brush shifting is manual through a handwheel and gears.

Heat insulating materials were shown by four manufacturers. The Armstrong Cork & Insulation Company displayed its regular assortment of insulating materials for hot and cold surfaces.

A feature of the Philip Carey Co.'s exhibit was a reaction of "Hi-Temp" insulation apparently unaffected after several months use on a steam main at 750 deg. F.

"Fraxite" high-temperature cement in the new plastic form was shown at the booth of the Celite Products Co. along with their regular assortment of "Sil-o-Cel" insulating bricks, "Celcote" boiler coating, etc.

An insulating cement consisting mainly of silica fiber was demonstrated at the booth of the Insulating Products Corp. While previously used in oil-field work, this cement has been but recently introduced for general power-plant work. It has the gray appearance of ordinary asbestos cement but is considerably lighter.

Of the manufacturers of continuous water softeners two showed minor improvements in their equipment. The International Filter Company exhibited an automatic level control device to shut off motors, valves and any other desired apparatus when the water in a distant tank reaches a predetermined level.

An improved hot-process softener in which the proportioning weirs formerly used were replaced by orifices was the principal feature of the exhibit of the Graver Corporation. In operation, the main portion of the raw water passes through a large orifice while a small fraction is bypassed through a small orifice. Special devices insure the same pressure difference across each orifice and hence a strictly proportional flow.

A new and improved form of the "Bentube" Evaporator was shown by the Griscom Russell Company. The construction is sectional, each vertical row of bent tubes being easily removable for inspection. The apparatus can be operated either as a film or submerged-type evaporator.

Photographs on exhibition at the booth of the Wheeler Condenser & Engineering Corporation showed the new "Ellipticoil" Wheeler film-type evaporator. The coils are of elliptical section for flexibility. The shell is vertical, with arrangements for its removal without disturbing the steam connections. This evaporator can operate with film or submerged evaporation.

New features of the exhibit of the Standard Water Systems Co. were a simple and inexpensive jet heater called an "economy unit" and a twin evaporator unit.

Much attention has been given of late to the research work in which the Bureau of Mines and the Hagan Corporation has co-operated for nearly three years. The main object of this investigation was to solve several difficult chemical questions that grew out of the first experimental applications of the Hagan Deconcentrator.

One of the conclusions from the research work was that chemical treatment of the feed should be controlled to maintain a certain constant "sulphate concentration" in the boiler, the proper concentration varying with the steam pressure.

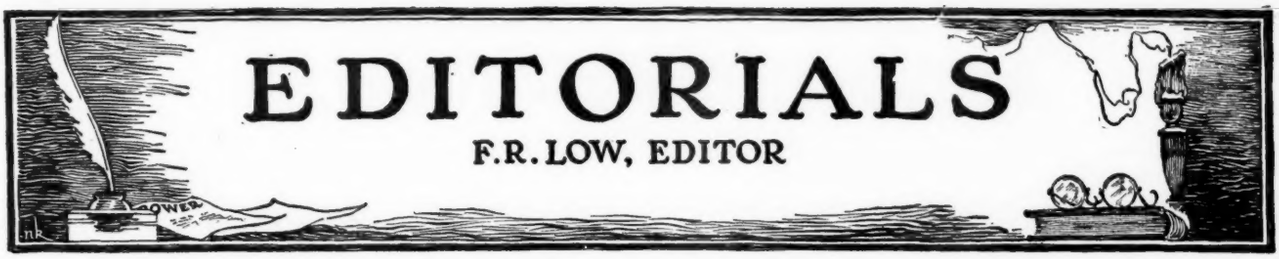
For the easy determination of this concentration the Hagan Corporation had on exhibition a newly perfected concentration gage of simple design. This consists of a rectangular glass jar with an electrically lighted prism on the back side designed to show a thin white line. After introducing 10 c.c. of boiler water and the same amount of acid barium chloride solution, to produce a milky condition, distilled water is poured in until the solution clears sufficiently to expose the sharp white line. Graduations on the jar permit the sulphate concentration to be read directly (in parts per million) from graduations at the final level of the liquid.

Protective coatings of various types were exhibited by several manufacturers. The Dampney Co. of America displayed special pushers and scrapers for the application of "Apexior" protective coating to the water surfaces of water-tube boilers and economizers. Protective paints and enamels for metal surfaces were shown by the Nitrose Company and the Wailes Dove-Hermiston Corp. The "X" Laboratories showed the "X" Liquid for repairing leaks.

A new "double surface" blow-off valve was shown by the Perolin Co. of America. This valve cleans and reseats itself. By turning the handwheel a worm is revolved in mesh with the geared valve disk, which is also in mesh, on the other side, with a rack. Thus the disk travels back and forth across the opening with a combined turning and sliding motion. A spring snap gives notice when the full open and closed positions are reached and also makes jamming impossible.

Having recently taken over the sale of Kerr turbines, the Elliott Co. showed an improved design. This was a two (Curtis) stage, 150-hp. 2,000-r.p.m. mechanical-drive turbine. The same design can be used for sizes from 10 hp. to 500 hp. Special features of this turbine are a specially designed emergency valve, drop-forged buckets, five carbon packing rings on each side and a continuous barrel casing with inserted stationary bucket holders.

Other Elliott exhibits were a single-stage 500-gal. per minute feed pump developing 250 lb. at 9,000 r.p.m., a single-stage motor-driven condensate pump running at 3,400 r.p.m. and a simple air delivery gage for attachment to the after condenser of an air ejector.



Conventions Should Help an Engineer

IT IS by no means exceptional to have an engineer express doubt as to the wisdom of attending the annual meeting of his society. He feels that the heavy traveling expense is not justified by the results of his attendance. This is due largely to the tendency of many societies to take up much of the convention's time in the reading of reports and other routine work that might well be carried on by committees. In fact, annual meetings have been held where such matters have precluded the reading of any engineering papers.

A happy example of what the annual meeting should be was the convention of the National Association of Practical Refrigerating Engineers held last month in New Orleans, and reported in the November 25 issue of *Power*. There were assembled from all points of the compass delegates from subordinates together with several hundred other members of the Society. Business matters were handled by committees meeting between the regular sessions. The engineers, upon attending a session, were not bored by tedious speeches on matters foreign to refrigeration, and their fund of knowledge was increased through papers read by authorities in the refrigerating field. Most interesting were the discussions which followed each address. Engineers who had problems to solve turned to those present for advice and guidance.

The convention was an inspiration to all who attended, and no one left with a feeling that the meeting had been profitless. It would be well if some other societies of practical engineers would send observers to the next convention of the refrigerating engineers with a view to adopting the system.

The Steam-Power Papers

WHILE steam power was perhaps somewhat less prominent at this year's A.S.M.E. annual meeting than last year or the year before, the papers presented contain material of solid worth. The fact that there are fewer pages to cover may mean their more thorough digestion by engineers.

Summing up recent advances in the art of water treatment, R. E. Hall placed officially before the Society information that he has already presented (in part, at least) elsewhere. That physical chemists are attacking important boiler-room problems is a hopeful sign of the times. It is to be hoped that Mr. Hall, or some other scientist with the necessary understanding of the subject, will undertake the difficult task of elucidating the theory and results of this research in a manner fully comprehensible to engineers untrained in physical chemistry. In this respect the present paper is a step forward from previous expositions of this research work, but a still simpler explanation would meet a real need of the busy engineer who is not a chemist.

The paper on resuperheating, by Blowney and Warren, is a concise analysis of the gains to be expected from resuperheating. The authors confirm the general opinion that more than one stage of reheating is rarely warranted.

For clearness of presentation among the papers of this group the prize should go to Henry Kreisinger for his paper on powdered fuel. There is an old saying to the effect that a man deeply learned in his subject cannot make it clear to others, but the rule does not seem to hold in this case. The test data presented by Mr. Kreisinger will be valuable for comparison with results obtained with stoker-fired plants.

W. A. Shoudy and R. C. Denny, in their paper on recent developments in the burning of anthracite coal, gave information of real dollars-and-cents value to engineers confronted with the problem of obtaining good ratings and efficiencies with "undersize" anthracite as a fuel.

Taken as a group, these four papers represent a substantial contribution to engineering knowledge.

Better Utilization of Fuel

WHILE we are confronted with improved means for burning fuel, utilizing heat, generating electrical energy and distributing it, one of the largest possible gains lies in the more complete utilization of heat that is at present wasted in a concentrated and wholesale manner. It must be remembered that fuel is not likely to be replaced by any other source of heat and energy in large degree for some time to come. Although energy cycles have made enormous gains in efficiency, two-thirds of the fuel is wasted in producing electricity under the best conditions. There are good reasons why such generating processes should be the most wasteful of our limited fuel heritage, and why the economy of the kitchen stove or the up-to-date domestic furnace is not likely to be approached by even the superpower system, for many generations.

There are many familiar examples of economical fuel utilization by combining an energy producing plant, at reasonably low efficiency, with a means of conserving escaping heat energy and using it for purposes other than energy production. These, however, are characteristic of small plants, and but few central stations have found it profitable to utilize exhausted heat energy to any appreciable degree. In the first place, the generation and sale of electrical energy on a large scale is a definite and well-defined business of itself, while that of selling or utilizing heat is, generally speaking, quite another. Since the generating cost of retailed current is about one-eighth of the total to the average consumer, an economy at this end does not appear impressive.

One of the greatest obstacles, however, to furnishing heat and electrical power in combination is the difficulty or impossibility of synchronizing the heating and power demand to a sufficient extent. In some instances this

is successfully accomplished, but in the majority of cases there is no demand for low head heat at hand, that will profitably absorb it.

In this connection it must be considered that future conditions must be expected to restrict the giant wastes. The purely heating plant is quite favorably situated with regard to fuel economy and the distribution of its product. There is little inducement for it to go afield for heat now wasted in power stations. It would seem that restricting the waste due to exhausted heat or providing other means for its utilization, would become eventually the lookout of the large station as an economic proposition rather than the problem of the consumer.

While it appears frequently that steam-heating and electric-power loads are best served by physically separated stations, since their peaks do not coincide, nevertheless one boiler plant has been enabled to operate at a better load factor for the combined service than two separate plants, from its ability first to supply heating peak steam direct, and later the power peak steam. Higher steam pressures and modern cycles make higher extraction and exhaust pressures possible. It is cheaper to distribute steam at pressures that are increased above that of the usual heating system. A long line may be utilized to some extent as a receiver, by varying the pressure of steam contained in it, tending by energy storage to assist in smoothing the boiler load.

A Little Business Foresight Needed

AS HAS been stated many times, our natural resources are limited and should be utilized, whenever possible, to yield the maximum benefits. Among these natural resources are our waterways, in which a number of conflicting interests exist, the most important of which are navigation, water power, municipal water supply, irrigation, industrial water supply and fisheries. All these seldom if ever occur on the same river, but two or more of them do on almost all the important streams of the country. These interests are not inseparable if the greatest benefits are to be obtained from these rivers. In fact a great economic waste can result if any program of development should be carried out that did not consider all interests that may exist.

If an intelligent and comprehensive plan for the most economic utilization of our waterways is to be evolved, then a complete knowledge of their characteristics must be available. An intelligent development of the power resources on a river system cannot be made without a complete survey of all the power sites, so that development at one site may be carried out with due regard for developing the others. Actual surveys of sites and tentative locations of dams and other structures must be made, so that when development takes place, the full resources of the stream may be utilized not only for power but for every other beneficial purpose.

This is the plan that the Canadian government has been carrying out with marked success. One of the best examples of this is the development of the Winnipeg River. In the one hundred and fifty miles between Lake of the Woods and Lake Winnipeg, there are eighteen falls which a survey has provided for utilizing at seven sites and includes the total fall in the river between the two lakes. Without this survey of the whole river no co-ordinated development program could have been provided for and a great economic loss might have been the result.

As pointed out in this year's report of the Federal Water Power Commission, notwithstanding the recommendations of President Roosevelt, in a message to Congress February 26, 1908, submitting the preliminary report of the Inland Waterways Commission, that there is urgent need for prompt and decisive action in utilizing our river systems, the failure complained of then still exists, even though the remedies advocated in the report are the same that should be applied now.

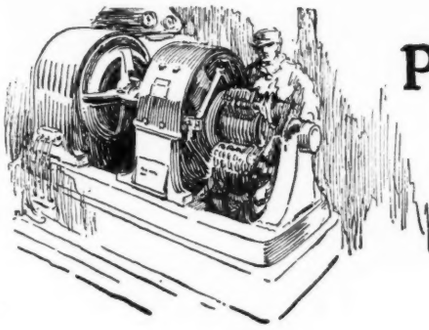
Although the Federal Water-Power Act provides for a co-ordinated study of our rivers, the commission has not been given the means to carry out such a program. The most deplorable part of such a policy on the part of the federal government is that such a program can be financed without any direct charge against the Treasury if the fees obtained from licenses for water-power projects are used for a program of river studies. Unless the present penny-wise and dollar-foolish policy regarding the development of our rivers is changed, it will result in great economic losses and a waste of our water-power resources, which can be corrected in the future only at great expense if at all, whereas if the proper business foresight is used, those losses and future expenses can be avoided.

John Lyell Harper

SOME men are apparently born to become prominently identified with the largest undertakings of their kind, and this seems to have been true of John Lyell Harper, as of other great men of vision and accomplishment. Born in a small country town, he grew up and graduated from a local seminary, entered college and, after four years, graduated with his engineering degree. During the next four years he wandered across the continent and back and in this period was identified with six different companies. Only the last, which is at Niagara Falls, provided the possibilities necessary to attract and hold one possessing his engineering imagination and genius. From this time on his life was closely interwoven with the romantic development of Niagara power.

Mr. Harper saw far beyond using Niagara Falls for power generation only. The beauty of this great natural wonder had a strong appeal to him, and he early advocated means for preventing the destruction of the Horseshoe Falls by erosion. Not being satisfied with conjecture as to what should be done in preventing erosion, he had a large model of the Falls constructed on the company's property, where the various schemes suggested could be tested. Here again his genius as an engineer did not fail, for the method he advocated proved to be the most satisfactory.

However highly he may have been held in the opinion of others as an engineer, those who knew him personally will always remember him as one of those wholly delightful human beings that manage to remain wholly human notwithstanding their great achievements. It has been said by one closely associated with him that "he never bossed his boys, yet all the engineering science, art and skill in that great organization paid tribute to his kindly, friendly direction and control." Those who knew him, know this to be typical of the man, who played such an important part in America's hydro-electric development.



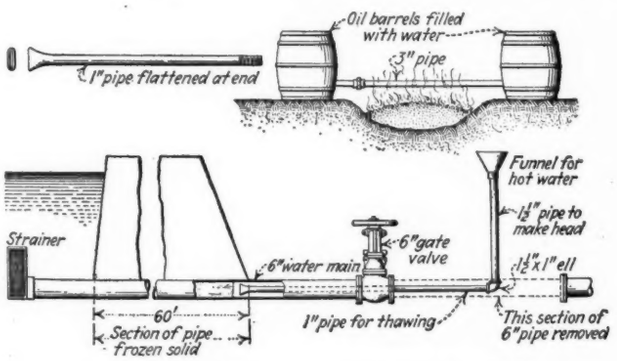
Practical Ideas *from* Practical Men

How the Sixty Feet of Pipe Was Thawed Out

The illustration shows the method we used for thawing out a 6-in. line in the breastwork of a dam that was frozen solid for a distance of about 60 feet.

During the winter months the reservoir was emptied and a plug placed in the end of the pipe, but through some leakage in the plug the pipe had filled with water and frozen solid.

In the spring, when we were ready to use the reservoir, the trouble was discovered. As there was no steam available, we decided to thaw out the pipe with hot water. After some planning, we ordered several lengths of 1-in. pipe, flattened the end of one length



Method employed in thawing out the pipe

to make a spray and placed it in the 6-in. pipe as shown. In order to heat the water, we connected two oil barrels with a piece of 3-in. pipe as shown in the sketch. The temperature of the water was raised to about 200 deg. and the water was then carried from the barrels in buckets and poured into the funnel. By this means we were able to thaw through the 60 ft. of ice in one day. As soon as the water broke through from the reservoir, we removed the 1-in. pipe and closed the valve.

Aquathuna, Newfoundland. R. K. WALSH.

Lack of Switchboard Instruments Causes Overloading of Engines and Poor Service

While the first cost of a complete equipment of switchboard instruments may seem high to the management of a small power plant, it often happens that the causes of some operating troubles may be traced directly or indirectly to the lack of such instruments. This fact was forcibly impressed upon me recently, when I was called by the owner of a plant to locate and remedy some of the difficulties that the operating force was having.

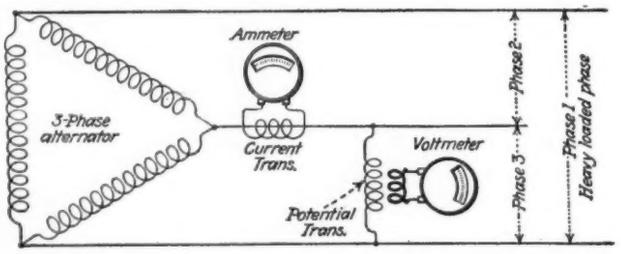
The plant consisted of two 100-hp. two-cylinder vertical two-stroke-cycle oil engines, each direct connected to a 75-kva. 2,300-volt, three-phase, 60-cycle alternator with a belted exciter. The switchboard had two generator panels, two feeder panels and one voltage regulator panel, each generator panel being equipped with the usual alternator oil switch, excitation switches, synchronizing receptacles, a voltage receptacle across one phase only, an exciter ammeter and one alternator ammeter. The alternating-current ammeter was connected through one current transformer installed in the middle wire of the three alternator leads coming to the switchboard buses. The plant supplied energy for light and power in a rapidly growing town of about 2,000 population and for water pumping on a small farm at irregular intervals, depending upon the season and kind of crops raised.

Upon my arrival the chief engineer outlined the difficulties he was having. He had been in charge of the plant for several months, during which time the number of customers had increased some 25 per cent. According to his statement, when he took charge of the plant either engine would easily carry a 17-ampere load, but in the last two months the engines were showing signs of distress on much smaller loads and on several occasions the pistons had siezed. Also, in part of the town, the voltage was low during the peak load, a condition that larger secondary wires had failed to improve.

It being about dusk when I arrived at the plant, I decided to observe conditions for myself. As previously stated, the switchboard generator panels were equipped with one alternating-current ammeter connected in but one wire of the three-phase circuit and with one voltmeter plug-in receptacle connected across but one phase. In the course of an hour, but one unit being in operation, the ammeter reading increased from about 4 to 11 amperes, by which time the engine was laboring and the exhaust very smoky. At my suggestion the chief had the second unit put on the line as quickly as possible, and by the time of peak load the ammeter on each unit indicated about 8½ amperes, which the engines carried nicely with clear exhaust. However, being familiar with this particular make of engine, it seemed to me that both engines were much nearer loaded than the ammeter indication would lead one to believe.

The chief insisted that the trouble was in the engines, but at the same time asserted that they were in fairly good mechanical condition. After the load went off later in the evening, we made a brief examination of each engine, finding the compression good, the fuel-injection timing satisfactory and the fuel pumps, injection nozzles and governing mechanism apparently in good shape.

Next morning I started to follow up the distribution lines. Before long I found about what I had surmised, which was, that approximately one-half the entire transformer capacity was connected across one phase of the system and the other half was fairly well divided between the other two phases. Tracing this heavily loaded phase back to the plant revealed that it was the phase that missed the switchboard ammeter entirely, as shown in the sketch. Further investigation showed that fully



Ammeter was connected on one phase and did not indicate true load conditions

half the entire system lighting load was connected through the transformers on phase 1.

Obtaining the services of a lineman, we transferred some of the load from phase 1 to phases 2 and 3 until the lighting load was approximately balanced on the three phases. That night as the load came on, the ammeter on the generator panel indicated considerably higher than on the previous night and came up to about 14 amperes before the engine began to show signs of distress. Taking a voltmeter out to the parts of the town that previously had poor lights, we found the voltage was now about normal.

The chief was still not satisfied because some time before he had been able to carry a 17-ampere load, while now, with a reasonably well-balanced load, the engines seemed fully loaded with the ammeter indicating 14 amperes or less. A little questioning disclosed that this so-called 17-ampere load consisted largely of a motor load for irrigation water pumping that had been on at intervals during the summer months. This motor was a 75-hp. 2,300-volt, three-phase, 60-cycle induction motor, but its actual load was only some 50 to 45 hp., hence it was operated at a comparatively low power factor. Further, this motor was used only during the day, when the power factor of the distributing system in town was also low.

The chief having no clear conception of the part that power factor plays in alternating-current circuits, I spent a long time in an attempt to explain the difference in conditions existing in direct-current circuits, with which he was familiar, and alternating-current circuits. How successful I was in this attempt, I will not say, but I seemed to get the idea across that there is a great difference between real and apparent load.

My recommendation to the owner of the plant was to install an indicating wattmeter on each generator panel so the operators could see at a glance the actual load on each alternator. Since potential transformers of spare capacity were installed on the board in connection with watt-hour meters on the feeder panels, it was necessary to purchase only one wattmeter and two current transformers for each unit, the total expense of which would be around $200. The records of the plant showed that nearly twice this amount had been spent in the previous three months for new pistons and machine work on pistons and cylinders that had stuck, an expense that was caused entirely by unintentionally overloading the engines.

So far I understand the wattmeters have not been purchased, but it is not likely that the present operating force in the plant will again have these same difficulties. As further line extensions are made or more customers are connected on existing lines, they will no doubt see that the circuit is kept reasonably well balanced. However, there is still likelihood of overloading the engines with nothing but voltmeters, ammeters and the sound of the engines to indicate what they are doing, especially when operating the two units in parallel, for one machine may be carrying almost the entire real load while the other has little except the reactive component and still the ammeters may indicate about the same current. On the other hand, it is not impossible that incorrect adjustments of an engine or the alternator field rheostat or the loss of excitation on one alternator when operating the two units in parallel, would cause heavy cross-currents between the two alternators, the ammeters indicating a high current while neither machine was pulling much of a load—a condition that is extremely confusing to an operator who does not understand what is happening.

J. H. BENDER.

Clayton, N. M.

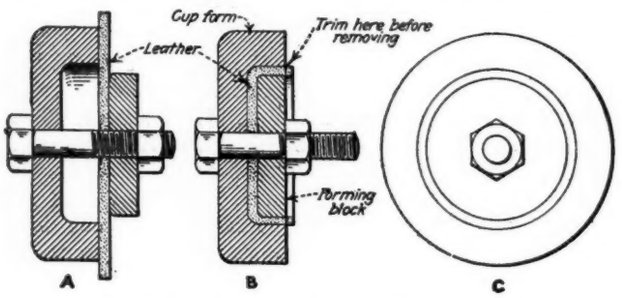
Mold for Forming Cup Washers for Pump Plunger

The illustration shows a form we use for making cup leathers for our hydraulic and house pumps.

The leather is soaked till it is workable, a hole is cut in the center for the bolt to pass through, and then the leather is placed on the outer frame, the inner piece is laid over the top and the nut screwed home, forcing the leather to take a cup shape as in view *B*.

It is then let stand till the leather is dry when the protruding edge is trimmed off before removing the cup from the form.

To get a good job it is necessary to know just what thickness of leather to use. Also the difference be-



Form for making cup leathers

tween the outside of the center form and the inside of the outer ring must be such as to give a reasonably tight fit with the leather in the form. All parts must be sufficiently strong to withstand the strain brought upon them by the process of squeezing the leather in the form.

Formerly, we bought our leathers and as they were soaked full of paraffin, we had to renew them often, but since we have been making our own and not using a leather preservative, we find that they last a great deal longer.

R. G. SUMMERS.

Rochester, N. Y.

Comments from Readers

Use of Compressed Air Permits Operating Duplex Pumps at Higher Speeds

In the Oct. 28 issue of *Power* W. V. Fitzgerald has an interesting article entitled "The Use of the Air Chamber on the Pump." It has been my experience that admitting a constant supply of compressed air to the pump air chamber will not only stop vibration and water hammer but will allow duplex pumps to be run at piston speeds as high as two hundred feet per minute.

In two different cases where duplex pumps were used to supply water to ammonia condensers, I have been able to more than double the quantity of water pumped merely by admitting a small amount of compressed air to the air chamber on the discharge line.

I have also noticed that when air is supplied to a pump discharging dirty river water into a settling pond, the sediment will drop out of the water in less than one-half the usual time.

B. C. WEAVER.

Napa, Calif.

American Condenser Practice

In the Oct. 21 issue an article appears under the title of "American Condenser Practice," and as an engineer who has studied this subject, I venture to make the following remarks:

In dealing with American practice the author appears to lay stress on three features: (1) The central flow of steam toward the center of the condenser, where it is withdrawn by the air pump; (2) The removal of the condensate from the main condensing section through water seals which prevent the escape of aërated vapor, but enable the condensate to leave the shell at the temperature of the steam entering the condenser; (3) The maintenance of a lower pressure in an air-cooling chamber into which the main condensate is discharged, so that ebullition takes place and deaëration is obtained.

On analyzing the article and the illustrations contained therein, one wonders to what extent these features, which are said to represent American condenser practice, are really new.

As long ago as 1886 an American inventor described in British Patent No. 9038 a condenser identical with that referred to under feature (1). In this patent the steam is admitted to the tubes from a passage that surrounds the whole of the condensing surface, and the air is withdrawn from the center of the condensing surface so that, as the inventor says, the cooling surface offered to the entering steam is augmented to a maximum and a greater and more even distribution of the steam is made over the whole of the surface. The inventor also states that the temperature of the cooling surface is equalized and the condensate is much hotter with the same measure of vacuum. This latter effect of obtaining condensate at a higher temperature by removing it as far as possible from the condensing surface surrounding the air outlet, corresponds with feature (2). The idea of removing condensate direct from the main section of a condenser through a water seal in order to obtain water at high temperature and at the same tive prevent aërated vapor entering the condensate pump, is of course quite old; for example, American Patent No. 816,811 of 1906 describes such an arrangement.

With reference to feature (3), which makes provision for deaëration by providing between the exhaust inlet and the air pump suction a chamber in which a lower pressure is maintained than in the main condensing section of the condenser, this feature must surely have the effect of increasing the pressure drop through the condenser. It is a generally accepted fact that the drop in vacuum between the exhaust inlet and the air-pump suction should be a minimum, otherwise the efficiency of the turbine must suffer. Deaërating the condensate by causing it to boil under a lower pressure is generally performed in a separate deaërating chamber quite apart from the main condenser.

If the article referred to really represents American practice, I venture the opinion that too much attention is being given to "selling stunts" at a possible sacrifice in condenser efficiency. The real duty of a successful condensing plant is to produce the highest possible vacuum at the turbine exhaust. The question of feed heating and deaëration should be dealt with separately by other apparatus provided for this purpose.

FREDERICK JAMES DROVER,
Engineer Commander, R.N.

Woodbridge, Suffolk, England.

Preventing Cracks in Boiler Settings

The article by W. H. Wakeman in the Nov. 11 issue, entitled "Preventing Cracks in Boiler Settings," is very interesting, and would apply to the setting of any type of boiler with brick walls. The brick setting of a return-tubular boiler is in most cases not as complicated as that required for the larger type of water-tube boilers. The large boiler setting, in addition to having a great depth and height, causing a greater amount of brickwork expansion, is subjected to the pressure of the furnace and relieving arches. This pressure or thrust tends to crack and break down the walls unless they are relieved by proper application of buckstays. In settings where there are no furnace arches, it is good practice to place horizontal buckstays in the walls opposite the combustion chamber. More recent construction at this point is the use of bonding tile or special brick, which is tied to the buckstays and prevents the furnace walls from bulging in. This bonding tile should run the depth of the furnace.

Brickwork expansion can be taken care of to a great extent by the use of a slip expansion joint. The expansion space should be at least two inches and extend the height of brickwork. These expansion spaces should be provided at each end of the front wall, and in each side wall at a point opposite the bridge wall. There

should also be an expansion space at each end of the bridge wall.

With regard to the fastening of cast-iron or steel fronts to the boiler settings that require steel supporting columns at front and rear of the boiler proper, it is not necessary in most cases to use brickwork anchor bolts. The fronts can be fastened directly to the supporting columns with short bolts, and not be subjected to a great amount of heat. However, proper provision must be made to allow for the expansion of the fronts, which can be taken care of by slotted bolt holes.

Barberton, Ohio. M. G. IRELAND.

Indicator Diagrams from Two-Cycle Oil Engine

In an article in the Oct. 21 issue entitled "Indicator Diagrams from Two-Cycle Oil Engine," there is shown a diagram that means little for lack of data as to pressures, but it does show what appears to be the result of late ignition due to retarded fuel injection. There is suggested in the article a probable cause for the high initial peak after the piston has traveled part of the stroke. As stated, the oil is injected by a pump at high velocity, and often the entire charge is within the cylinder before ignition occurs. If such were the case, the high peak would be a continuation of the compression curve in the case of auto-ignition.

In the event of a high-velocity injection pump properly timed, there would be a flattened peak as in the case of a constant-pressure cycle engine where the fuel is injected so as to maintain that result. In other words, the fuel is injected at a rate sufficient to produce the power and yet prevent complete combustion of the entire charge until after the piston has started to move on the power stroke.

To inject the total charge before ignition takes place would give a condition similar to that of a constant-volume cycle engine with a high initial peak based on the compression pressure and a given fuel ratio, the result being either high initial pressure and severe strain or low mean-effective pressures due to limited fuel volumes.

The Scotch Walker dual-cycle and French Sabathi mixed-cycle are based on a combination of both the constant-volume and constant-pressure cycles where the former causes ignition, while the latter delivers a sustained pressure after the piston moves.

Referring to the Walker result, British Patent No. 118,934, page 6, lines 34 to 37 is quoted: "Thus, in spite of the fact that the expansion ratios and the maximum pressures are the same in these two cycles (Walker and Diesel) yet the dual combustion cycle, with a lower compression ratio than the Diesel cycle, has a higher efficiency and a greater mean effective pressure." Such a result should be of interest.

It will be evident that a single-injection jet is useful only when designed to operate in conjunction with a pump having a relatively long stroke for full load and a stroke variable in proportion to the power output; also, that the stream of fuel is burned up as soon as it enters the combustion space and in proportion to the volume behind the piston if a constant pressure is to be maintained.

The term solid injection means that no air is used to atomize or inject the fuel and any air that is permitted to enter the fuel system will tend to upset the system by acting expansively in the pump and during ignition, thus producing irregular results and resulting in poor control or regulation.

Also, surplus lubricating oil is churned into a vapor by the crank and is transferred from the crankcase to the combustion space, and this interferes with the fuel regulation. It may also reduce the apparent fuel consumption at the expense of the more costly lubricating oil. Perhaps, the most detrimental result is that the transferred oil vapors may cause preignition during an overload condition. Such a condition may prove disastrous; even a backfire is not impossible, owing to after-burning with an enriched charge in conjunction with delayed exhaust-port opening followed by the entry of a fresh charge of air and oil vapor.

Let us assume that the direction of rotation of a crankshaft is counterclockwise and that the piston-side thrust is on the transfer port side of the bore during the power stroke; then the condition is ideal as an oil pump. The surplus is picked up by the crank and is thrown off at the transfer-port side and into it, just previous to the transfer of the air to the combustion space. Again, such an arrangement puts the side thrust on the weakest side of the cylinder bore during the down or power stroke.

To produce ideal conditions the port may be located on the opposite side, so that the side piston thrust is delivered on the exhaust side where the bore is reinforced, while the transfer port will be free from the effect of surplus oil thrown off the crank.

Such a design will certainly tend to eliminate preignition due to the transfer of crankcase oil vapors. The lubricating oil that is consumed as fuel may cause the engine to show a lower fuel consumption, but at the expense of the more costly lubricating oil.

Cleveland, Ohio. JAMES MCINTOSH.

Boilers for Heating Purposes

Referring to the communication in the Nov. 18 issue relative to "Boilers for Heating Purposes," I do not think that the architect should be unduly censured for the peculiar arrangements of heating apparatus sometimes found. He quite often is not so well advised by the engineers he consults as he might have been.

Sometimes the architect, especially in his early practice, in his zeal in his client's interests, accepts the proposition of an astute representative of a manufacturer to furnish "free" engineering if their apparatus is specified. Such engineering is often wierd, so far as items are concerned that are not directly connected with the apparatus specified, unless the salesman has a wide experience.

In most cases where high-pressure steam could be used to advantage, it will be found upon investigation that the building was never intended to house such processes.

In cases where both high- and low-pressure boilers are found, they are usually the outgrowth of an unforseen demand and in due time the low-pressure boilers will be superseded.

A collection of various types and sizes of boilers may be due to expediency. It may have been necessary to get heat into the building in a limited time, in which case it is not necessarily poor architecture or engineering to put in the apparatus available immediately. Second-hand equipment may even be justified. That the owner, so long as it will work, will not replace it

with the proper equipment, cannot be laid to the door of either the architect or the engineer.

The fact that in many localities the person operating a boiler must be licensed if the pressure exceeds 15 lb., is responsible for many low-pressure installations. The owner will lend a ready ear to the argument that he can save money by having apparatus that can be looked after by a janitor or night watchman, instead of paying the wages a man with a license naturally commands.

It is my opinion that any architect or engineer should advise his client to install reasonably high-pressure boilers, to provide for possible unknown demands in the future, but he should not be disgruntled if he is forced to admit that at the time it is not the most economical proposition. If he puts his recommendations in writing, there can be no criticism in the future if the client prefers to be governed by financial rather than engineering considerations. C. M. DURGIN.

Providence, R. I.

Using Indirect Radiation to Heat Combustion Air

An editorial in the Nov. 18 issue asked for comments on the practicability of using an indirect exhaust-steam heating system for preheating furnace air during the summer months.

The practice of preheating combustion air is not by any means new where the products of combustion are utilized as the heating medium, as Howden's forced-draft system is a practical application of this principle, but the preheating by the process of reclaiming heat units from the exhaust steam suggests a novel and attractive method of increasing the boiler efficiency and consequently the over-all thermal efficiency of a steam installation.

As all engineers are aware, there are many more heat units carried away by the exhaust steam than there are in the gases escaping up the smokestack, and if the exhaust steam is not utilized for process work or heating, it should be made to give up some of these heat units, that have been produced at great expense.

In order to enable us to decide whether there is any benefit to be derived from the adoption of the indirect radiation system, it will be necessary to conduct a brief and simple investigation of the means at our disposal and their various properties. This will give some clue as to the commercial feasibility of the proposition.

In the first place, one pound of exhaust steam will give off approximately 1,000 B.t.u., or one pound of steam per hour will supply four square feet of radiation surface; therefore one square foot of radiation surface will give off 250 B.t.u. per hour.

Assuming that the engine uses 21 lb. of steam per horsepower per hour and this amount, due to condensation, loses its latent heat to the extent of, say, 10 per cent; the heat available at the radiator will be, roughly, 19,000 B.t.u. per horsepower per hour. Again, assuming that each pound of coal evaporates 7 lb. of water, it follows that the coal consumption will be 3 lb. per horsepower-hour. Now as the fans are to be used solely to supply air at natural-draft pressure—say ½ in. of water—the excess air will probably be as high as 100 per cent. This works out approximately to 20 lb. of air per pound of coal. From the foregoing we now deduce that 60 lb. of air is required per horsepower per hour.

The air should leave the radiator at a temperature of approximately 200 deg., and this being the case it will absorb $60 \times (200 - 70) \times 0.23 = 1{,}794$ B.t.u. per hour (taking 0.23 as the specific heat of air at constant pressure) so that it will be observed that there is a vast margin of heat units in the exhaust steam.

As there will probably be a loss of heat in the air duct during the passage of air to the furnace, an allowance of 10 per cent will be made, which will reduce the temperature to 180 deg., and this will increase the furnace temperature by an additional 360 deg., or an increase of approximately 15 per cent. This at a modest estimate should produce a saving on the coal bill of about 10 per cent.

In mechanical-draft installations an allowance of one-half per cent to one per cent of the total power is made for the power to drive the fan or fans, but as the pressure in the case cited, is very small, I think the lower figure will be adequate.

Judging from the results obtained from the foregoing investigation, it appears that the proposition is a real money saver, and taking into consideration the cost of a new fan and motor (or engine) should the present machine be unsuitable, and also allowing for the cost of air ducts and alteration to the furnace fronts, the results would apparently justify the outlay. Take for instance a small power plant consuming 20 tons of coal per day at a cost of $5 per ton; the saving would amount to $10 per day, a condition that would soon pay off the initial expenditure on the installation.

The results gained will of course depend to a great extent on the efficiency of the radiator, and in all probability a system of baffling will have to be introduced in order to insure that the air absorbs a maximum of heat units. It would perhaps be possible with a suitable system of ducts and air control to heat sufficient air for the requirements of the boiler and building at the same time, but this is perhaps taking a too optimistic view of the possibilities.

It will be interesting to hear the opinions of other readers of *Power* on this subject.

Detroit, Mich. ROBERT MELROSE.

[The computations of Mr. Melrose are of interest, but it seems likely that he has overestimated the percentage of saving obtainable with 180 deg. air.—Editor.]

Chain Grate vs. Underfeed Stokers for Lignite Coal

Referring to the article by G. B. Thomas in the Nov. 25 issue, entitled "Chain Grate vs. Underfeed Stokers for Lignite Coal," I would say that this subject would open up a great deal of controversy with advocates of both types of stokers, since both have successful installations burning this kind of fuel.

I am familiar with an underfeed-stoker installation where Montana coal of about 9,000 B.t.u. is used with satisfactory results. However, it is my opinion that the most satisfactory way of burning this fuel is in pulverized form. I would recommend the unit-system of pulverized fuel; that is, one pulverizer for each boiler.

With a properly designed furnace and a reliable pulverizer this system will give continuous good efficiencies, because the difficulty of maintaining a uniform fuel bed, which will be encountered with any type of stoker, is eliminated. JAS. WATT.

Chicago, Ill.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Balanced Valve with Pressure Plate

How can I reduce leakage of a balanced gridiron valve with pressure plate? *J. C. A.*

Balanced valves with pressure plates usually have the pressure plate held at the right distance from the valve back by distance pieces whose thickness can be varied to compensate for the wear of the valve. If the valve faces are cut or worn so the leakage would not be cured by adjusting or reducing the distance pieces, it will be necessary to reface the rubbing surfaces and adjust or reduce the thickness of the distance pieces to suit the reduced thickness of the valve.

Boiling Out a Boiler

How is simmering or boiling out of a horizontal return-tubular boiler performed, for the purpose of cleaning it of grease and scale? *D. R.*

Boiling out usually is performed after the boiler has been blown off and washed as clean as possible with a hose. The boiler is then filled with clean water to a point higher than the upper limit of oil or scale deposit and a liberal amount of soda ash added, the quantity depending on the size of the boiler. For a 72-in. horizontal return-tubular boiler use 30 to 40 pounds. The efficiency of the soda ash is increased by the addition of about one-tenth of its own weight of caustic soda. The soda ash, and caustic soda if used, should be dissolved before it is put in the boiler. When the charge of soda solution has been added, a slow fire should be built in the furnace and maintained two or three days with regulation of the heat so the water will be kept boiling gently. Leave the manhole or other openings uncovered so there will not be accumulation of pressure. When the boiler has been "boiled out," washed and ventilated, the scale that has been loosened should be removed and the boiler cleaned with hand tools or mechanical cleaners as soon as possible, so the scale that has remained attached will have little time to become harder from drying.

Percentage of Tank Capacity Discharged for Stated Reduction of Air Pressure

If a closed water supply tank is filled two-thirds with water and one-third with air at the pressure of 100 lb. gage, and sufficient water is discharged to reduce the air pressure to 75 lb. gage, what will be the percentage of total tank capacity so discharged? *A. E. B.*

The exact volume of the air after expansion will depend on the temperature conditions, the amount of moisture in the air and the amount of air liberated out of the water during the expansion. However, for practical purposes, the process may be taken as isothermal expansion of dry air, for which the volume varies inversely as the absolute pressure. On this assumption the initial 33⅓ per cent volume of air at the pressure of 100 lb. gage, or 100 + 14.7 =114.7 lb. per sq.in. absolute, when expanded to the pressure 75 lb. gage, or 75 + 14.7 = 89.7 lb. per sq.in. absolute, would have a volume of $33\frac{1}{3} \times 114.7 \div 89.7 = 42.6$ per cent of the total tank capacity, and the volume of water discharged would be the same as this increase of air volume, namely, 42.6 — 33⅓ = about 9⅓ per cent of the total tank capacity.

Frequency of Blowing Down Boiler

How often should a boiler blowoff valve be opened during regular operation? *W. M.*

The frequency of blowing down depends on the character of the feed water and tendency to accumulation of sediment. When the water contains mud and other impurities, or there is precipitation of solid or sludgy material from the use of a boiler compound which settles in the form of a sediment, it may be advisable to blow down an inch of water, as shown by the gage glass, every two or three hours. The frequency must be decided from conditions found when the boiler is opened. When the feed water is free from sediment, as when it consists of condensate from heating systems or surface condensers, it may not be necessary to blow down at all during operation of the boiler.

Providing Supplemental Exhaust When Required for Heating

One of our paper machines is driven by a combination of a 350-hp. throttling-governor engine and a 125-hp. constant-speed motor. We have a 350-hp. Corliss engine belted to a 200-kw. generator and can make use of the electrical output. Can we run the latter engine noncondensing with back pressure of 18 lb. gage to supply any deficiency of exhaust steam required by the paper machine in excess of the exhaust of the paper-machine engine, which at present is made up with live steam, and what would be the method of regulation?

C. P. C.

It would be feasible to operate the 350-hp. engine as proposed, to provide the shortage of exhaust steam required by the paper machine or otherwise, and the electric power obtained may be regarded as a byproduct. The method of regulation would be to control the live-steam supply to the engine from the exhaust pressure in such a manner that when the back pressure becomes more than necessary, the live-steam supply to the engine will be reduced, causing the engine to shirk the electric load. There should be a back-pressure relief valve to prevent excessive back pressure from any cause, and the generator should be protected against reverse current if the engine is prevented from taking steam.

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Initial Strains and Stresses in Metal

AMONG the many peculiar phenomena with which practical engineers are familiar is that known as "season cracking." It sometimes happens that hard-drawn tubing of brass, bronze or other alloy develops cracks for no apparent reason.

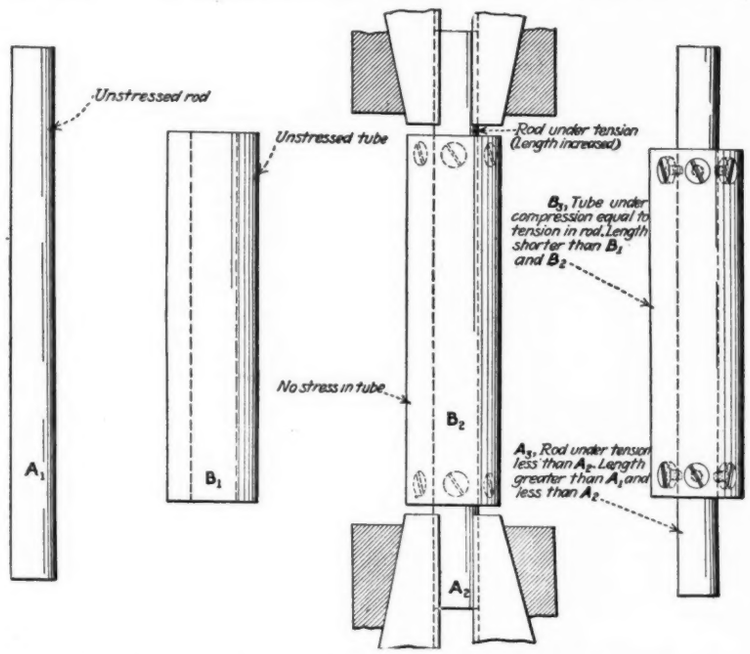
At times these cracks develop, without any apparent external aid in tubes lying quietly and apparently not exposed to either chemical or mechanical action. The superficial similarity between the formation of such cracks and those that develop in the drying or seasoning of green timber is perhaps responsible for the term "season cracking."

In other cases contributory causes, such as slight corrosion or a small amount of bending or vibration, enter in, but are evidently not the primary cause of the trouble.

Investigations during the last few years have definitely proved that season cracks are primarily due to strains or stresses present in the product when it leaves the factory, and that they can generally be prevented by skillful handling of the metal in the manufacturing plant.

Before going into the discussion further, it is important that the distinction between strain and stress be made clear. The fundamental difference is that stress refers to force, while strain refers to the distortion or changes of dimensions. As we ordinarily think of it, stress is the cause and strain the result, although the opposite may be argued with a considerable show of logic. From the practical point of view the only essential point is that they always occur together.

Suppose a square steel bar of four square inches cross-section and 100 inches length is held rigidly at the upper end while a weight of 10,000 lb. is attached to the lower end. The total stress will be 10,000 lb. The unit stress—that is, the stress per square inch of cross-section—will be 10,000 ÷ 4 = 2,500 lb. per sq.in.


Unstressed rod
Unstressed tube
Rod under tension (Length increased)
B_3, Tube under compression equal to tension in rod. Length shorter than B_1 and B_2
No stress in tube
A_3, Rod under tension less than A_2. Length greater than A_1 and less than A_2
A_1
B_1
B_2
A_2

Construction of a model with internal strains and stresses

The weight will stretch the bar elastically, that is, within the limit where it will return to its original length when the pull is removed. Suppose the amount of this stretch is 0.008 in., which is about in line with what would actually happen. This will then be the total strain or change in length. The unit strain, or the change in length per running inch, will be 0.008 ÷ 100 = 0.00008 in. per inch. Where strain and stress are due entirely to the application of external forces, as in this case, they are known as load strain and load stress.

Now how can such stresses and strains exist in a piece of metal lying, say, free on a table? If part of the metal is in tension, it means that it is being pulled or stretched. With no external load, the pulling is possible because another part is in compression.

To get the idea, consider a brass tube and rod as shown at A_1 and B_1. The rod just fits within the tube. Both rod and tube are at the start completely free from strain and stress.

Now slip the tube over the rod and clamp the ends of the rod in the jaws of a tensile testing machine, applying a heavy tension. The rod, being under tension, is slightly elongated, while the tube is unaffected. Next, with the tension still on the rod, attach the tube to the rod by tap screws (shown dotted at B_2) at each end.

If now the tension is removed, as shown at B_3 and A_3, the rod will "try" to return to its original length. To do this it will have to compress the tube. What finally happens is that the rod goes back until the remaining total tension in it just balances the compression produced in the tube.

If the tube and rod had been joined continuously (say by depositing copper electrically in the joint) instead of at the ends only, the result would have been the same. And if such a composite rod were put in a lathe and the outer shell turned off, the remainder of the rod, being freed from tension, would shorten a little. The reverse effect could be obtained by putting the rod in initial compression before joining it to the tube. On release the rod would still be in compression and the tube in tension. Turning off the outer shell would release the compression of the center section and allow it to lengthen.

Similar effects are produced in solid rods, tubes, etc., by cold working. Take a round rod of soft steel entirely freed from stress by complete annealing. Then peen the surface all over. This tends to stretch the metal on the surface, which, however, is held back by that in the center. The final result is that the surface metal is in compression and that in the center in tension.

If this rod is turned down in a lathe, it will act just like the composite rod. This change in length when part of the metal is removed, is the basis of one of the standard methods of finding whether internal stresses exist. Other methods involve sawing slots in various ways and noting the bending or change of shape. While the details of this procedure are highly interesting, space limitations make it necessary to postpone their description.

Where hard tubing is used for heaters, evaporators, condensers, etc., it is important that internal stresses be removed. Where softness is permissible, ordinary annealing will do the trick. If hardness is necessary a scientifically controlled "low-temperature" anneal will remove most of the initial stress without greatly impairing the hardness. The action seems to involve a slight yielding of the stressed portions.

American Society of Refrigerating Engineers Holds Annual Convention

THE twentieth annual meeting of the American Society of Refrigerating Engineers was held in New York City, Dec. 1 to 3. After the reading of the minutes of the Spring meeting and the reports of various committees, the tellers reported that the new officers elected for the coming year were: President, Van R. Greene, New York; vice-president, W. H. Carrier, Newark, N. J.; treasurer, John A. Mikesell; secretary, W. H. Ross, New York.

George A. Horne, the retiring president, outlined in a scholarly address the dependence modern civilization places upon the engineer. He laid emphasis on the argument that force never settled any problem and that logical reasoning must take the place of international warfare.

The society took the occasion, it being its twentieth birthday, to honor its first president, John E. Starr, and received much inspiration from his talk on the state of the refrigerating art twenty years ago contrasted to its present status.

In a paper on "Central Station Pipe Line Refrigeration," A. W. Oakley, of the Merchants Refrigerating Co., New York, outlined the development of the system of his company from three small isolated plants. Brine is pumped through underground pipe lines to the consumers' freezer boxes. Insulation of the lines is by three layers of 1-in. hair felt and a final covering of roofing paper. Leaks at joints are not numerous, Van-Stone and packed sleeve joints being used. The rates charged depend upon the temperature needed. For cooler boxes the charge is 13.8c. per cubic foot per year and for freezer boxes under 32 deg. F. the charge is 15c. Power for piping is about 0.1 kw. per ton, while the compressor power is 1 kw. per ton.

Rotary Ammonia Compressor Tests Show High Power Consumption

The results of tests conducted on a small rotary ammonia compressor were presented by Prof. H. J. Macintire, University of Illinois. This compressor consisted essentially of a casing within which an eccentric was rotated by the shaft. The eccentric did not touch the casing, there being an oil seal of 0.0015 in., and the gas is constrained from flowing around the eccentric by a sliding tongue swiveled to the casing. The general impression is that the rotary compressor cannot be made tight enough to hold ammonia gas. However, in this compressor there were no blades rubbing the cylinder wall and it was felt that this eliminated much of the objection to the rotary. Tests after 6,500 hours of continuous operation revealed but a small capacity reduction and the machine was capable of more service. The volumetric efficiency was good, but the horsepower ran as high as 2.10 per ton.

The speaker expressed the belief that the rotary type was suitable for small units and its simplicity more than offsets its extra power consumption.

A paper on "The Electrically Driven Ice Plant," by Fred Ophuls, aroused much interest since the majority of the plants being erected are using purchased current and efficiency in plant operation is imperative. The fundamental principle of plant design is that the equipment must be so chosen that it can perform its task in complete harmony with all the other apparatus and do so with efficiency and reliability. One of the main points to be determined very early is the can capacity of the tanks per ton of ice. There are some engineers who advocate 9 cans per ton while others go as high as 18. The quality of the water available for ice making is also of great importance. It is well to analyze the water if not taken from the city mains. The speaker felt that the cooling supply and the pumping arrangement seldom received the consideration due this part of the system. In deep-well pumping the air was recommended on account of its simplicity.

Number and Size of Units

The number and size of the refrigerating machine units needs very careful consideration in these plants. To get best results, one must segregate the refrigeration process into two distinct operations. The first is the cooling of the ice-making water from its initial temperature to about 34 deg., and the second, the cooling of the liquid ammonia circulated in the plant from the lowest temperature that it can be reduced to by the cooling water available, to from 30 to 32 deg. F. This work should be done by a special refrigerating machine, and if this machine is properly proportioned, it can be done at from 35 to 40 lb. gage pressure.

The second refrigerating process is the manufacture of ice itself in the freezing system and the cooling of whatever ice storage the plant may have. Depending on the number of cans per ton of ice frozen and corresponding brine temperature and brine-cooling equipment, this refrigerating work is done at anywhere from 15 to 25 lb. gage in summer and up to 35 lb. the rest of the year.

Why Two-Stage Machines Should Be Installed

While for handling the water for the liquid cooling system, a single-stage compressor can be used on account of the low ratio of compression, two-stage machines for the actual ice making should be installed for the following reasons: A compound machine maintains its refrigerating capacity practically constant, irrespective of the ammonia condenser pressure. This is of vital importance in an ice-making system, as maximum ice output is desired during the hottest period of the year. The reason for the constant capacity of a two-stage machine is that the intermediate pressure in these machines changes but slightly with the change in condenser pressure.

The two-stage machine operates with a lower final discharge temperature both in the low-pressure and the high-pressure cylinders than the single-stage machine. This low temperature is valuable from an operating point of view, particularly as to lubrication. The low temperature of the discharge gases also is favorable to the long life of the valves.

A good deal has been written and said for and against compound compression, but much of this has been based on hearsay and on improperly conducted tests. When it is remembered that from an efficiency point of view, the claims made for compound machines are expressed only by small percentages, great care must be exercised when making tests to determine the efficiency of compound compressors to reproduce all the favorable conditions that are needed to obtain, finally, the advantage that is claimed above the single-stage machine. It is impossible to take two compressors of different sizes and hook them up as a compound machine unless the connecting link is properly designed. It is also necessary that the two compressors that are taken have all the characteristics that the compressors of a compound machine must have, so that the final results will be correct.

Clearance Pockets

Another much-discussed feature of modern refrigerating machines is the clearance pocket. It has been proved beyond doubt that clearance pockets, if properly designed, will not decrease the efficiency of the machine to an extent that is measurable with the instruments available at this time. The human error in making tests is larger than the difference between the efficiencies of a compressor operated with the clearance pockets open and with the clearance pockets closed.

For an electrically driven ice plant, compressors with clearance pockets are practically indispensable if it is desired to obtain the lowest power consumption for the plant for all variations possible in ice output.

The question of ammonia condensers is also a very important one, not only on account of maintaining the lowest possible condenser pressure, but also to keep the power required to circulate the cooling and condensing water at a minimum.

Open-air and double-pipe condensers do not give these economies. The atmospheric type, particularly in cities, must be placed at a considerable height above the ground, and therefore the pumping head is large. While the double-pipe type can be placed anywhere, the pumping head through these condensers is always high if one desires to circulate through them a quantity of water consistent with proper heat-transfer efficiency.

For a considerable number of years shell-and-tube type ammonia condensers have been installed. These condensers have none of the disadvantages of the older types, can be readily cleaned, give lowest condenser pressure when properly purged and, above all, do not hold up the liquid.

Wherever possible, the vertical shell-and-tube type condenser should be installed, as it is easier to keep clean and therefore maintains its efficiency more readily than the closed type. In some plants the open vertical type cannot be used and most excellent results have been secured with the horizontal closed type. It has often been possible to reduce materially the power required to circulate the water through the horizontal closed type by so constructing the water discharge connections to act as siphons. In this way the hydraulic head is materially reduced and only the friction through the piping and the apparatus must be overcome by the pump.

In citation of what careful design can accomplish, operating data on two electrically driven plants were given. In one of them the kilowatt-hours per ton of ice ran as low as 34.6, while in a second plant, when a cooling tower was necessary, the power consumption was 54.8 kw.-hr. per ton. Part of this poor showing was traceable to the auxiliaries which used 27.9 per cent of all the power.

Small Town Ice Plants

A survey of ice plants in small Indiana towns was reviewed in a paper entitled "The Small Town Ice Plant," by Prof. E. F. Burton, of Purdue University. It was found that almost without exception, such plants are most inefficient. This can be attributed to the ignorance of both the engineer and the owner. The latter is never a technical man and is interested only from a business viewpoint, consequently he does not know how to check the operating results. The engineer, while frequently a good mechanic, knows little of the fundamentals of ice making and does not know how plant conditions can be improved.

The speaker stated that the belief was current among such plants that the consulting engineers were working in the interest of some one of the machine builders. Their recommendations as a consequence were not considered impartial. The investigations revealed that many of these plants could, by slight alteration, decrease the coal consumption by half.

In a paper on "Water-Cooling-System Efficiency," Victor J. Azbe pointed out that low-temperature condensing water was more necessary in the refrigerating plant than in the steam plant. The power of a steam engine decreases 3 or 4 per cent for each 10 deg. increase in water temperature, while the power required to drive a compressor increases 30 per cent for a like rise in condenser temperature. It was necessary, then, to cool the water, when re-cooling was used, to as low a temperature as possible. The author expressed the belief that the choice of cooling apparatus was between the atmospheric tower and the spray system, the preference being the tower.

Legal Duties Concerning Boilers

By A. L. H. Street

That an operator or owner of a steam power plant is not absolutely liable for injuries that may result to person or property through explosion of a boiler, is a proposition of law that has often been reaffirmed by the courts.

There is probably no decision that more clearly presents the law governing responsibility for explosions due to neglect or oversights of repairmen or inspectors than does the opinion handed down by the Pennsylvania Supreme Court in the case of Anderson vs. Hays Manufacturing Co., 207 Pennsylvania Reports, 540. In that case it was decided that judgment had been improperly awarded in favor of the plaintiff on account of injury to his property when a boiler exploded on the defendant's adjoining premises.

About ten years after the defendant had installed the boiler in its manufacturing plant, a leak was discovered. Defendant's manager employed a reputable boilermaker to inspect and repair the leak. A patch was placed over the leak in a customary manner. About six months later another leak developed, and it was repaired by an expert boilermaker and the boiler was tested. A short time after that the explosion occurred.

The boiler had been insured by a reputable company, which had caused quarterly inspections to be made, and a few weeks before the explosion it had been reported by the insurance company to be in good condition.

The evidence tended to show that there were grooves and cracks in the boiler of such nature that an inspection should have disclosed them any time within several preceding months.

Abstract from Opinion of Supreme Court

The Supreme Court said, in the course of an extended opinion:

"It was the duty of defendant, acting by its officers, to employ competent mechanics to make the repairs, to exercise reasonable care in ascertaining their competency, and then to see to it that they did the work intrusted to them; that as reputable machinists and skillful workmen they adopted a plan for the repairs and carried it out. Of course, further than this he could not go. He had neither the knowledge nor the skill requisite to enable him to determine whether a proper inspection had been made by the men he employed, whether they had adopted the right plan or adopted the right method to carry it out. It was not his duty to bring to the performance of the work personal mechanical skill and the knowledge of an expert; but his duty was more than the mere perfunctory employment of two mechanics to do a certain job of repairs. It was that of an employer having in charge a powerful force, dangerous to his employees and the neighborhood unless reasonable care was exercised in keeping it in a proper condition of repair. He was bound to know, either from the observation which a non-expert could make, or from the reports of the mechanics themselves, that the work required of them had been done."

The Supreme Court granted a new trial because the trial judge erred in instructing the jury to the effect that, even if the machinists employed to repair the boiler were competent and if the inspections by the insurance company were carefully made, nevertheless defendant could not avoid responsibility for the explosion, etc. The Supreme Court said:

"This is not the law. It either makes the owner of a boiler—as nearly every manufacturer is—an insurer, or it compels each owner to be an expert boilermaker, which he is not. . . . It was the personal duty of defendant to see that the boiler was kept in repair. If, after knowledge of the leak, he had unreasonably neglected to have it repaired, and an explosion had occurred, he would have been answerable for the neglect of a personal duty. And when, in the performance of duty, he ordered the repairs, it was still his further duty to select competent persons to make them, and either from their reports or from other sources, know that the work had been done by those who knew best how to do it. He knew there was a leak in the boiler. The exact location or extent of the fracture causing the leak he did not personally know and could not ascertain, because he did not have the mechanical skill and knowledge. There was no personal duty on the vice-president to crawl through the manhole into the boiler to ascertain, and, if he had done so, it is doubtful if such an act would have increased his knowledge of the nature and extent of the fracture. . . .

"Hundreds of accidents from the use of powerful machinery happen every year which are not traceable to the fault of anybody; accidents which no human care could guard against, except by the abandonment of the use of machinery. It does not follow that for every such accident someone must respond in damages to an innocent injured party."

But, in concluding, the court added that "No manufacturer can turn over the supervision of his boilers and machinery to an insurance company and thereby exempt himself from the penalty of negligence by the mere report to him that his boiler is in safe condition. He must go further and prove that the insurance company's inspectors were competent, that they did properly inspect and truthfully report, if he invokes the full weight of the act in his favor on the question of due care."

The Society of Industrial Engineers, 608 S. Dearborn St., Chicago, held its annual meeting in Chicago on Nov. 18 and the following officers were elected: W. G. Sheehan, Detroit, president; Edward T. Miller, Chicago, treasurer; George C. Dent, Chicago, executive secretary; Prof. Charles B. Gordy, Ann Arbor, vice-president in charge of research; Eugene A. Rummler, Chicago, vice-president in charge of promotion; Prof. Walter F. Rittman, Pittsburgh, vice-president in charge of education; Louis B. Dorr, Buffalo, and Prof. George H. Shepard, Lafayette, Ind., directors to fill vacancies.

Coolidge Advises Sale or Lease of Muscle Shoals

The message of President Coolidge to the Congress which met on December 1 for the short session contained the following recommendations regarding the disposal or utilization of the government property at Muscle Shoals:

"The production of nitrogen for plant food in peace and explosives in war is more and more important. It is one of the chief sustaining elements of life. It is estimated that soil exhaustion each year is represented by about 9,000,000 tons and replenishment by 5,400,000 tons. The deficit of 3,550,000 tons is reported to represent the impairment of 118,000,000 acres of farm lands each year.

"To meet these necessities the government has been developing a water-power project at Muscle Shoals to be equipped to produce nitrogen for explosives and fertilizer. It is my opinion that the support of agriculture is the chief problem to consider in connection with this property. It could by no means supply the present needs for nitrogen, but it would help, and its development would encourage bringing other water powers into like use.

"Several offers have been made for the purchase of this property. Probably none of them represent final terms. Much costly experimentation is necessary to produce commercial nitrogen. For that reason it is a field better suited to private enterprise than to government operation. I should favor a sale of this property, or a long-time lease, under rigid guarantees of commercial nitrogen production at reasonable prices for agricultural use. There would be a surplus of power for many years over any possibility of its application to developing the manufacture of nitrogen. It may be found advantageous to dispose of the right to surplus power separately with such reservations as will allow its gradual withdrawal and application to nitrogen manufacture. A sub-committee of the committee on agriculture should investigate this field and negotiate with prospective purchasers. If no advantageous offer be made, the development should continue and the plant should be dedicated primarily to the production of materials for the fertilization of the soil."

Senate Defers Consideration of Muscle Shoals

When the Senate, in conformity with its agreement at the last session, took up the Muscle Shoals bill on Dec. 3 consideration of the measure was deferred by unanimous consent. In the discussion of this proposal the President of the Senate raised the question as to whether or not, under the terms of the agreement, the measure could be displaced by other business. He opposed recommitment to committee.

Federal Oil Commission Advocated

Creation of a permanent Federal Oil Commission with a view to conservation is recommended by Secretary of Interior Work in his annual report which was recently made public. The report states, according to the press:

"The production of oil from the public lands, exclusive of the naval petroleum reserves, amounted to nearly 40,000,000 bbl. during the year, from which the government obtained nearly 8,000,000 bbl. of royalty oil, valued at slightly more than $12,000,000.

"Of this sum 90 per cent was returned to the states, either directly or through the Reclamation Service, and the remaining 10 per cent went to the Federal Treasury to cover the cost of supervision. The actual cost is about one-third this amount, the remainder being available for general expenses of the government. Supervising the production and gauging of the 40,000,000 bbl. cost the government only $250,000.

"The formation of a permanent Federal Oil Commission to include the Secretaries of War, Navy, Interior and Commerce, to study the conservation of our oil deposits and more thorough and economic methods of recapture, to be comprehended in a national continuing oil policy, is an urgent necessity in the interests of the public."

Hospitality Well Expressed at Chicago Engineers' Club

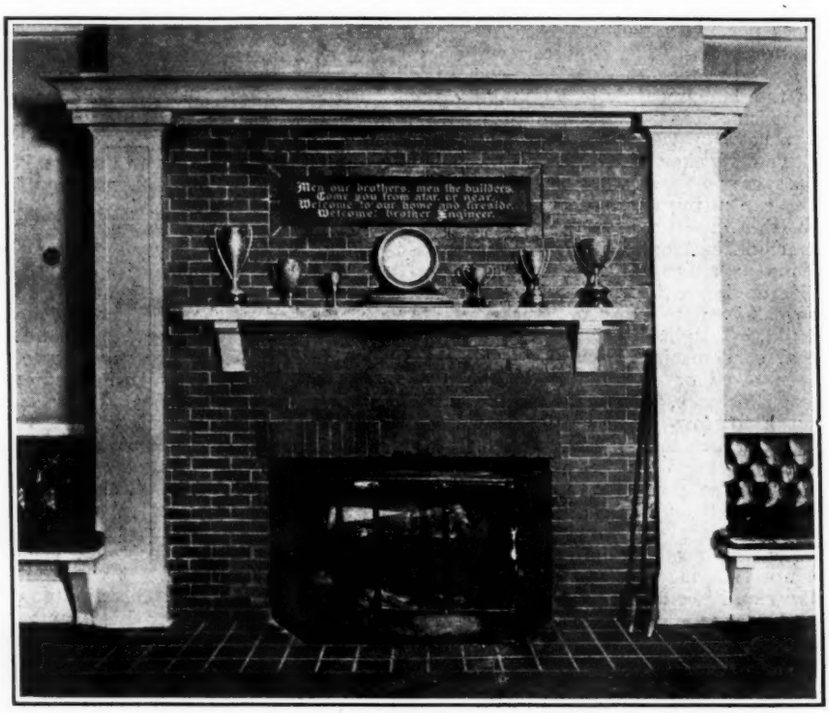
The visible symbol of welcome and hospitality has always been the hearth or fireside and in most languages the word for hearth has this meaning.

The founders of the Chicago Engineers' Club which is on South Federal Street, Chicago, wishing to make the symbol a visible part of the spirit of the club has had a bronze tablet inscribed with the verse:

> Men our brothers, men the builders,
> Come you from afar or near,
> Welcome to our home and fireside,
> Welcome! Brother Engineer.

This tablet has been placed directly above the fireplace as an over-mantel and so carries the welcome to all who come within the warmth of the fire.

The late Isham Randolph, one of the founders of the club, was the author of the sentiment. The thought or inspiration for its composition was the outgrowth of a casual conversation between Mr. Randolph, Mr. Onward Bates and Mr. C. F. Loweth and others of the older members of the club who felt that the genial warmth of the fire and its intention should be suitably voiced.



Chicago Engineers Club's welcome to brother engineers

Lehigh Engineers Discuss Pulverized Coal

That pulverized fuel is a live subject among engineers at the present time was demonstrated on the evening of Friday, Nov. 28, when approximately 200 members attended the annual joint meeting of the Lehigh Valley Section of the A. S. M. E. and the Engineers Club of the Lehigh Valley, in Drown Hall, Lehigh University, Bethlehem, Pa., to hear lectures on this subject. Papers were presented by H. G. Barnhurst, advisory engineer of the Fuller-Lehigh Co., C. H. Frick, assistant to superintendent of operation, Pennsylvania Power-Light Co. and Henry Kreisinger, research engineer, Combustion Engineering Corp. A written discussion of Mr. Frick's paper was presented by H. B. Jones, plant engineer of the Susquehanna Colleries Co., at Lykens, Pa.

Mr. Barnhurst, who was the first to speak, expressed the opinion that the large increase in the use of pulverized fuel during the last few years augurs well for the future of this type of fuel. He added, that its adoption by many of the largest public-service corporations and engineering companies is significant, for it was not long ago that any effort to introduce pulverized coal was considered premature. Mr. Barnhurst dealt principally with the field of application of pulverized coal and told of activities along that line. Over twenty-five million tons of pulverized coal are being burned annually in the United States at the present time. About eight million tons are being used in the cement industry, between six and seven million tons for the generation of power and the remainder is used in industrial furnaces mainly for metallurgical operations. In addition, new plants are now under construction that will consume an additional four or five million tons.

Report of Tests Made at Lykens

The use of powdered coal is as safe as stoker firing, Mr. Barnhurst claimed, if the equipment is properly designed. It is dangerous only when it is not handled properly, as are oil, gas and the boilers themselves. The proper design of pulverized-coal plant is governed by the fundamental requirement of safety.

In his paper on the "Use of Pulverized Anthracite Coal for Steam Generation," Mr. Frick gave a report of a series of tests conducted at the Susquehanna Colleries at Lykens. He outlined the system employed at Lykens for burning anthracite slush in pulverized form, which he said had been in successful operation for about three years. Tests were made on nine different coals from the anthracite region lying between Lykens and Scranton. The coal as received from the mines all passed through a $\frac{3}{32}$-in. screen and more than 60 per cent through a 100-mesh screen. The coal was pulverized in screen separating type mills, and the tests were made with coal varying in fineness from 58 to 76 per cent through a 200-mesh screen. Mr. Frick said that the test had demonstrated that the fineness of the coal above 70 per cent made but slight variation in the boiler results. A CO_2 of between 13 and 15 per cent was obtained, and the fact that a minimum rating of 50 per cent was easily obtainable with a CO_2 between 8 and 9.5 per cent gave evidence for wide range of operation.

In discussing this paper, Mr. Jones said that, initially, the low volatile content of the coal was expected to introduce difficulty in igniting a fire and in maintaining ignition at low rates of combustion, but as the work progressed it became evident that the differences from the performance of bituminous coal had been much over estimated. Change in furnace design had eliminated the provision originally made in the furnace to insure proper ignition, without encountering any trouble, but with considerable increase in capacity. As operated at present, the furnaces are very similar to present bituminous practice and could unquestionably use that fuel without change. He said, as a result of the test referred to by Mr. Frick, that for the last three months they have operated the station with coal having a fineness of 70 per cent through a 200-mesh screen instead of 82 per cent as formerly. This is being done without any change in boiler-room practice or performance or decrease in the evaporation per pound of fuel. He added that it has also been well established that any of the boilers can be operated as low as 50 per cent of rating without difficulty in maintaining ignition of the flame.

Four Types of Installations Described

Mr. Kreisinger spoke on the design of pulverized-coal plants and described four different types of installations, pointing out some of the relative advantages and disadvantages of each type. He considered the arrangement of the equipment very important, and although it was becoming more or less standardized, it was influenced to some extent by local conditions and personal fancies of the plant owner. The plants described by Mr. Kreisinger and illustrated with slides included four different arrangements of boiler and preparation equipment: (1) Preparation plant located beside the boiler; (2) preparation plant in the same building as the boilers but in a separate compartment; (3) preparation plant in a separate room above the boilers; (4) preparation plant in a separate building. From the viewpoint of safety he was inclined to favor the use of a separate compartment in the boiler house or a separate building for the preparation equipment. He pointed out the danger of having any direct opening in the furnace walls through which the fine dust might be drawn by induced draft should some be spilled accidentally close to the furnace. By the employment of hollow furnace walls through which the secondary air is carried for some distance before being admitted to the furnace, this danger is eliminated. A slide was shown giving the results of twenty-two tests at the plant of the Cleveland Electric Illuminating Co.; an efficiency for boiler, superheater and economizer of 92 per cent at 200 per cent of rating had been obtained and an average of 90 per cent at 280 per cent of rating. For the boiler alone the efficiencies were 84.5 and 82 per cent respectively. At 100 per cent of rating the temperature of the flue gases leaving the boiler was around 450 deg. and leaving the economizer, 200 deg.

Two More Diesels for Los Angeles

The City of Los Angeles, Calif., has placed an order for two 1,125-hp. Fulton-Diesels. These engines will be used in the city water pumping stations in connection with two other Diesels installed some months ago.

Power Development Started at St. Narcisse, Que.

The Shawinigan Water & Power Co. has started another power development at St. Narcisse on the Batiscan River, Que. The company's subsidiary, the North Shore Power Co., has a power development at this point, with an output of 1,200 hp., which will be abandoned upon the completion of the redevelopment of the site, to obtain 10,000 hp. The new development includes the construction of a dam just about Grande Chute and the construction of a tunnel 13 ft. in diameter and 3,500 ft. long, which will bypass the existing plant to a new power house site further down the river at Chute des Cheminées. The work is expected to be completed in May, 1926.

Senator Underwood's New Muscle Shoals Bill

A new bill dealing with Muscle Shoals was introduced in the United States Senate this week by Senator Underwood of Alabama. Its main provisions are:

That the government plants be used for the production of fertilizers and other useful products in time of peace and of explosives in time of war, at least 10,000 tons of nitrogen to be produced the first year as a condition of any lease, 20,000 tons the second, 30,000 tons the third, and thereafter 40,000 tons annually, profit on sales not to exceed 8 per cent.

That the Secretary of War be authorized to lease the plants for a period not to exceed fifty years at an annual rental not less than 4 per cent on the cost of Dam No. 2 and the hydro-electric works and machinery in connection with it, the lease to prescribe the terms under which the lessee may sell surplus power.

That if the Secretary of War is unable to make a lease before July 1, 1925, then the government shall operate the properties through a corporation to be known as the Muscle Shoals Corporation, controlled by a board of five directors appointed and removable by the President, of which the Secretary of War shall be chairman; the powers of this board and the method by which it shall function are described.

That the Secretary of War shall complete Dam No. 3, with such modifications as he may deem advisable in the interests of power and navigation, this dam to be leased or operated in conjunction with Dam No. 2.

Engineer Makes Report on Tennessee River Dam No. 2 and No. 3

Necessity for Dam No. 3 Dependent on Distribution of Power from Dam No. 2 and Steam Plant—Dam No. 3 Worthy of Construction

DAM NO. 3 on the Tennessee River will be needed by 1931, in the opinion of Maj. Max C. Tyler expressed in a special report to the Chief of Engineers, if the power from Dam No. 2 is distributed through the interconnected system of the southeastern power companies and into new territory southwest of Muscle Shoals. Since four years will be required to build Dam No. 3, almost immediate action must be taken toward securing the necessary legislative authority and the appropriation. If it should be found feasible to operate the nitrate plant, Dam No. 3 would be needed in 1929, Major Tyler says.

Others of Major Tyler's conclusions, based on this latest engineering report on Muscle Shoals, are briefly:

If the power from Dam No. 2 and the steam station is not distributed through the power companies transmission net, it will take a long period to load up the two plants, and there would be no justification at this time for the construction of Dam 3. The load factor on the plants would be low and the cost of power correspondingly high.

If power is supplied only for the operation of Nitrate Plant No. 2, and local and new territory distribution, the time when the capacity of Dam 2 and the steam plant will be reached, also is problematical. Nitrate Plant No. 2 requires about 100,000 hp. at full load. If assumed that Nitrate Plant No. 2 will use 75,000 hp. in three years, or say 450,000,000 kw.-hr. per annum, there will remain available capacity of about 400,000,000 kw.-hr. per annum for local and new territory distribution, which would have to be absorbed before Dam No. 3 would be needed.

Dam No. 3 is worthy of construction by the United States at the present time provided, before authority for construction is given by Congress and appropriation of funds is made, that Dam No. 2 and the steam plant are leased under the provisions of the Federal Water Power Act so as to insure distribution through the interconnected system and in new territory. Or, if the plants are operated by the United States and power is sold, that long term contracts, at such prices for generator voltage power at the plants as will pay maintenance and operating expenses and a reasonable rate of interest and depreciation on the capital invested in the three plants for power purposes.

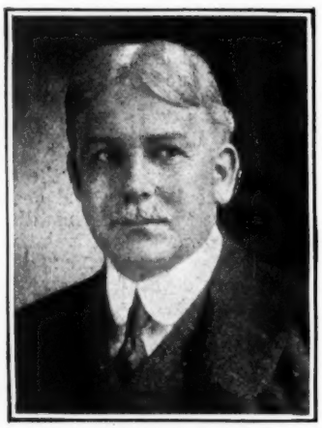
"About $3,100,000 in capital investment can be saved to the government by building Dam 3 with the organization and plant now available at Dam 2.

"The quantity of power that can be produced by the government plants at Muscle Shoals so greatly exceeds the amounts that may be required for fixation of nitrogen that the nitrate plants should be considered only as prospective large customers of the power plants. The solution of the nitrate-plant problem should be made on its own merits, on the assumption that power will be available. It should not obscure the fact that the greatest use, largest returns and cheapest power can be obtained only by a wide distribution of power through the interconnected transmission system.

"Storage at the headwaters will increase the quantity so materially and decrease the cost of primary power produced by run of river plants, such as Dam 2 and Dam 3, that the survey of the Tennessee River and tributaries being made by the district engineer at Chattanooga, should be completed at the earliest possible date."

John Lyell Harper, Noted Hydro-Electric Engineer, Dies

On the morning of Nov. 28, John Lyell Harper, chief engineer and vice-president of the Niagara Falls Power Co., died at the Memorial Hospital, Niagara Falls, after undergoing an operation for appendicitis on Monday Nov. 24. Mr. Harper's work in the development of Niagara Falls power made him a national figure in hydro-electric engineering. He had been associated with the Niagara Falls Power Co. and its predecessor, the Hydraulic Power Co., for 22 years, starting as assistant engineer. Under his leadership the plant in the gorge below the falls grew from one of 14,000 hp. to one that today contains nearly one-half-million horsepower under one roof, the largest installed capacity in any power plant in the world. The recent completion of this work was his crowning engineering achievement, which he saw completed before his death.



John Lyell Harper

Mr. Harper was 51 years old, having been born in Harpersfield, N. Y., in 1873. His boyhood was typical of the country lad on the farm. He made the most of the local school and at the age of twenty graduated from the Stamford Seminary, a few miles from his home. Four years later he graduated from Cornell University with the degree of mechanical engineer. In 1898 he married Linda E. Wheeler, of Ithaca, who survives him with two sons and three daughters.

After graduation from college Mr. Harper went west as a draftsman with the Oregon Improvement Co., Seattle, Wash. Four months later found him with the Union Electric Co., of Seattle, which gave him an opportunity in the electrical field. In June, 1898, about one year after graduation, he was made operating and construction engineer of the Twin City Rapid Transit Co. This brought him in contact with the work, which was to make him a national figure in engineering. Among his other duties was the responsibility of operating a 10,000-hp. water-power plant. However, this job held his attention for only about a year, when he became interested with I. W. Gray & Co., of Minneapolis, in the design of an electric railway and steam-power plant for Mankato, Minn. In September, 1899, he became associated with Messrs. Floy & Carpenter, consulting engineers, New York City, and this again brought him into the hydro-electric field. While with this firm he was their field representative in charge of design and construction of the Apple River hydro-electric plant and a 30-mile 25,000-volt transmission line for the St. Croix Power Company.

His wandering was soon to come to an end, for in 1902 he came to Niagara and obtained a job, as he was wont to call, it with the Niagara Falls Hydraulic Power & Manufacturing Co., as assistant to the engineer, Wallace C. Johnson. The bigness of Niagara Falls, with it almost unlimited possibilities, apparently was suited to the man. From the time he first became associated with its development 22 years ago, the life of John Lyell Harper is the romantic story of power development at Niagara Falls. After two years at Niagara Falls he became chief engineer of his company, a position which he held until his death. Under his leadership from 1902 to 1918, the gorge plant had grown from one of 14,000 hp. to 160,000 hp.

Mr. Harper was also vice-president and chief engineer of the Harper-Taylor Co., consulting engineers. He was prominently identified in the membership of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Electrochemical Society, the American Ceramic Society and the Engineers' Club of New York City. Niagara Falls Country Club and the Niagara Club.

San Joaquin Merged with Great Western

Announcement is made by H. P. Wilson, president of the Western Power Corp. of New York, that that company had acquired control by purchase of stock, of the San Joaquin Light & Power Corp.

For several months the Western Power Corp. has held an option on the San Joaquin property the exercise of which was delayed pending the fixing of a price on the common stock of the company.

Personal Mention

Prof. G. W. Patterson, assistant dean of the Engineering College, University of Michigan, has been granted a leave of absence to study power developments in Europe and Africa, and will sail with Mrs. Patterson about Feb. 1.

F. E. Weymouth, who recently resigned the office of chief engineer in the United States Reclamation Service, has become president of Brook & Weymouth, Inc., an organization with offices at 1607 Walnut St., Philadelphia. Mr. Weymouth's experience in water works, canal surveys, dams and irrigation projects, together with his supervision and active engineering work, are extensive. This new company has been organized to furnish information for scientific studies of engineering projects, and for this purpose will utilize the Brock patented aërial process and equipment in making topographic maps, a process by which contours can be rapidly and accurately drawn on maps from photographic information.

Society Affairs

The Seattle Section of the A.I.E.E. will hear L. D. Beach speak on "Electrical Features of the Long-Bell Lumber Co. Developments," at its meeting on Dec. 17.

The New York Association of Building Superintendents, Regnald Byron, 730 Fifth Ave., New York City, will hold its annual meeting on Dec. 17, for election of officers and other business.

The Detroit Engineering Society will hear W. L. Steffens, manager of the insulation department of the Philip Carey Co., speak on "Heat Conservation by Insulation," at its Dec. 12 meeting.

The Pittsburgh Section of the Association of Iron and Steel Electrical Engineers will have as the subject for its Dec. 13 meeting "Welding." The meeting will be held at the William Penn Hotel.

The Providence Section of the A. S. M. E. will have as the subject of its Dec. 12 meeting, "Present Day Economizers and Radiant Heat Superheaters," by Pell W. Foster of the Power Specialty Co.

The New York Chapter of the American Association of Engineers will at its Dec. 9 meeting, which will be held in the McAlpin Hotel, hear Major David M. Oltarsh speak on "The License Law."

The Connecticut Section of the A.I.E.E. will have "Engineering Co-operation and Prosperity" by Hon. James T. Harkness, president of the American Engineering Council, as the attraction for its Dec. 11 meeting.

The Cleveland Section of the Association of Iron and Steel Electrical Engineers will have "Special Features in D.C. Control," by W. Dean as the attraction for its Dec. 13 meeting, which will be held in the Electric League rooms, Statler Hotel.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution Washington, D. C. Meeting at Washington, Dec. 29-Jan. 3.

The American Boiler Manufacturers Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Midwinter meeting at Cleveland on Feb. 12.

American Ceramic Society. R. C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Convention at Columbus, Ohio, Feb. 16-21.

The American Engineering Council. L. W. Wallace, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 16-17.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at New York City, Feb. 9-13.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 16-19.

American Petroleum Institute. R. L. Walsh, 15 West 44th St., New York City. Annual meeting at Texas Hotel, Fort Worth, Texas, Dec. 9-11.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 22-26.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 33 West 29th St., New York City. Annual meeting at Boston, Jan. 28-30.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Que. Annual meeting at Montreal, Que., Jan. 27-29.

Illinois Society of Engineers. E. R. Tratman, Wheaton, Ill. Meeting at Chicago, Jan. 14-16.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Des Moines, Iowa, Jan. 27-30.

Kansas Engineering Society, Ernest Boyce, Lawrence, Kansas. Meeting at Lawrence, Kan., Dec. 10-12.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

The National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **New England States Association** at Worcester, Mass., June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven.

National Marine Engineers Beneficial Association, Geo. A. Grubb, 313 Machinists Building, Washington, D. C. Convention at Hotel Franklin Sq., Washington, D. C., Jan. 19.

Society of Automotive Engineers. C. F. Clarkson, 29 West 39th St., New York City. Annual meeting at Detroit, Mich., Jan. 20-23.

West Virginia-Kentucky Association of Mine, Mechanical and Electrical Engineers. Herbert Smith, Huntington, W. Va. Fourth annual convention at Frederick Hotel, Huntington, W. Va., Dec. 12-13.

Western Association of Electrical Inspectors. G. M. Miller, 1304 South 7th St., Louisville, Ky. Annual convention at the Brown Hotel, Louisville, Ky., Jan. 27-28.

Trade Catalogs

Buckets—The Brown Hoisting Machinery Co., Cleveland, Ohio. "Brownhoist Clamshell Buckets," Booklet No. 8, contains full descriptions of this equipment.

Rust—American Rust Proof Co., 8 West 40th St., New York City. "Rust and Rust Prevention" is the title of a pamphlet just issued by this company, describing "Vatu" a compound for rust prevention. Those interested may obtain copies on request.

Pyrometers—Brown-Instrument Co., Philadelphia, Pa. Catalog No. 14, recently issued, is filled with useful information respecting the instruments manufactured by the company and also pyrometer installations, types, price lists, as well as other instruments.

Insulating Materials — Johns-Manville, Inc., 292 Madison Ave., New York City "Service to Industry," is the name of the new catalog just issued by the company. It is a 260-page book describing asbestos roofings, heat insulations, packings, electrical insulations, water-proofing industrial flooring and other materials manufactured by the company.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal, net tons.	Market Quoting	Nov. 24, 1924	Dec. 1, 1924
Pool 1	New York	$3.00	$3.00
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.25	2.25
Somerset	Boston	2.35	2.35
Kanawha	Columbus	1.65	1.65
Hocking	Columbus	1.75	1.75
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.40	2.50
West Ky.	Louisville	1.75	1.75
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	1.90	1.90

FUEL OIL

New York—Dec. 4, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal.; 36@40 deg., 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Nov. 26, f.o.b. local refinery; 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5¼c. per gal.

Dallas—Dec. 2, f.o.b. local refinery, 26@30 deg., $1.15 per bbl.

Philadelphia—Nov. 25, 28@30 deg., $2.10@$2.163 per bbl.; 18@20 deg., $1.87½@$1.93¾; 13@16 deg., $1.764@$1.827 per bbl.

Boston—Dec. 1, tank-car lots, f.o.b.; heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati—Nov. 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5½c. per gal.

New Plant Construction

Ariz., Tombstone—The City Council is having preliminary plans prepared for the construction of an electric-light plant. Engineer not selected.

Ark., Batesville—The City will soon award the contract for a new one million gallon water purification plant, to include motor driven and marine engine driven pumps, one 350 g.p.m. and one 500 g.p.m. basins, clearwell, etc. Estimated cost $58,000. C. Barnett is secretary of Board. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Calif., Long Beach—Heartwell Bldg. Co. awarded the contract for the construction of a 12 story office and store building at Ocean Ave. and Pine St.; to Stradley & Newton, Insurance Exchange Bldg., Los Angeles, estimated cost $600,000. Address owner care of contractors.

Calif., Long Beach—Pacific Electric Ry. Co., 6th and Main Sts., is receiving bids for the construction of a 1-story, 43 x 33 ft. electric sub-station, estimated cost $18,000. Owner will purchase equipment later.

Calif., Long Beach—People's Ice & Cold Storage Co., Alamitos, is having plans prepared for the construction of a 2-story ice cream plant on East Anaheim St., estimated cost $40,000. Seibert & Hedden, Brock Bldg., are architects.

Calif., Merced—Merced Irrigation Dist., H. P. Sargent, Secy., will receive bids until Dec. 16 for 4 booster pumps, one 24 in. centrifugal and three 12 in. to 14 in. direct connected. R. V. Meikle, is chief engineer.

Calif., San Francisco—E. Fritz, c/o E. E. Young, Archt., 2002 California St., is having plans prepared for the construction of an 8 story, 110 x 150 ft. apartment house at Mason and Sacramento Sts.

Calif., San Diego—J. D. Spreckels, Spreckels Bldg., had plans prepared for the construction of a 13 story, 100 x 200 ft. bank, store and office building on Broadway. J. & D. Parkinson, Title Insurance Bldg., Los Angeles, are architects.

Fla., Miami—Bowman-Biltmore Hotel Corp., Biltmore Hotel, Madison Ave. and 43rd St., New York, plans to construct a hotel at Buena Vista Ave. and Columbus Blvd., here; estimated cost $10,000,000.

Ga., Atlanta—Atlanta Ice & Bottling Co., 273 Courtland St., plans improvements to its boiler house, including installation of 3 new boilers. Lockwood, Greene & Co., Healey Bldg., Atlanta, and 24 Federal St., Boston, Mass., engrs., have been retained to supervise the work.

Ga., LaFayette—The LaFayette Cotton Mills are having plans prepared for complete electrification of their plant. Lockwood, Greene & Co., Healey Bldg., Atlanta, and 24 Federal St., Boston, Mass., are engineers.

Ill., Chicago—Eitel Bros., 177 West Randolph St., are having sketches prepared for the constructon of a 22 story hotel, theatre and office building; estimated cost $2,000,000.

Ill., Chicago—University of Chicago plans to construct a group of buildings to include a hospital and medical school, two library buildings, dormitory, chapel, gymnasium and refectory. Estimated cost $17,500,000. E. DeWitt Burton, is president.

Ill., Sterling — Charter Gas Engine Co. plans to construct a new factory in the spring and will purchase oil engine generator set to generate own electric current. E. E. Chase, 645 North Michigan Ave., Chicago, is engineer.

Ia., Iowa Falls—The City plans to hold an election to vote on proposition to grant franchise to the Iowa Falls Electric Co., 412 Washington Ave., to build hydro-electric plant and dam in Iowa River.

La., New Orleans—Sewerage and Water Board, A. G. Moffat, Secy., Room 401, 526 Carondelet St., will receive bids until Jan. 26, for furnishing and installing two 1250 hp. and two 350 hp. motors, complete with switchboards, cables and compensators, instruments and auxiliary appliances. G. G. Earl, Supt.

Mass., Boston—Loring, Coolidge, Noble & Boyd, 40 State St., are having preliminary plans prepared for the construction of an 8 story office building at Hanover and Court Sts., estimated cost $500,000. C. G. Loring, 7 Water St., is architect.

Mass., Dorchester (Boston P. O.)—Public Buildings Dept., City Hall, plans the construction of a Chronic Hospital at Parker Hill; estimated cost $1,000,000. Architect not selected. The City Council will vote on appropriation.

Mass., Worcester—The City and State plans to construct the third additional pumping unit at the Wachusett Reservoir of the Metropolitan Water System to furnish auxiliary water supply to the depleted Worcester Reservoirs, also install a new pump, estimated cost $50,000. J. R. Rablin, Metropolitan Dist. Comn., 1 Ashburton Pl., Boston, is engineer.

Minn., Faribault — The City, S. M. Andrew, Recorder, plans to hold an election Dec. 11 to vote on $560,000 bonds for electric light and central heating plant, also electric distribution system. A. L. Mullergren, Gates Bldg., Kansas City, Mo., is consulting engineer.

Mo., Kansas City — The City is having plans prepared by Fuller & Maitland, engineers, 600 Walnut St., for improvements to waterworks, including tunnel from North Kansas City to south side of river, also one to Turkey Creek Station, lifting station, purification and filtration plants, etc.

Mo., St. Joseph—The City plans to hold an election Dec. 16 to vote on $300,000 bonds for electric light plant. Former election defeated. W. K. Seitz, City Hall, is engineer.

Mo., St. Louis—Hotel Jefferson Co., 12th St. and Locust Blvd., is having plans revised for a 13 story addition to hotel; estimated cost $2,500,000. T. P. Barnett & Co., Arcade Bldg., are architects.

N. J., Spring Lake—Borough Council, P. S. Brown, Clk., plans to improve water plant machinery and equipment and install water softening system and feed water heater, estimated cost $20,000.

N. Y., New York—American Union Bank, 10 East 22nd St., has awarded the contract for the construction of a 24 story bank and office building at 39th St. and 7th Ave., to Shroder & Koppel, Inc., 347 Madison Ave.

N. Y., New York—Arthur Brisbane, 238 William St., awarded the contract for the construction of an apartment and store building at Park Ave. and 57th St., to Todd, Robertson & Todd Corp., 347 Madison Ave.; estimated cost $2,000,000. Steam heating system will be installed.

N. Y., New York—J. P. Morgan, Wall and Broad Sts., is having preliminary plans prepared for the construction of a 30 story office building at 15 Broad St.; estimated cost $12,000,000. Trowbridge & Livingston, 527 5th Ave., are architects.

N. C., Raleigh—The City plans to purchase an electric emergency pump to cost $20,000 and lay a 12 in. main on Halifax St. W. Olsen is engineer. The City Commissioners have issued an ordinance providing for $200,000 bonds for enlarging the city water system.

O., Blanchester—Bd. of Trustees, C. Reed, Clk., will receive bids until Dec. 17 for the construction of 5 m.g.d. water treatment plant and furnishing pumps for same. The Jennings Lawrence Co., is engineer.

O., Cleveland—Cleveland Railway Co., G. L. Radcliffe, Vice-Pres., Hanna Bldg., awarded the contract for the construction of a 1 story electric sub-station on Central Ave., to W. I. Thompson & Son Co., Chester-Twelfth Bldg.; estimated cost $50,000.

O., Euclid—The Ajax Manufacturing Co., H. D. Hemen, general manager, 3830 Lakeside Ave., Cleveland, had plans prepared for a manufacturing plant, including a 60 x 60 ft. boiler house. Estimated cost $350,000. Withington-Roberts-Wright Co., Swetland Bldg., Cleveland, are engineers.

O., Martin's Ferry—The City will soon receive bids for the construction of a new combined light and water plant, including boilers, fans and stokers, two 1,000 kw. turbines, surface condensers, induced draft fans, breeching, feed water heater and water treating, boiler feed pumps, balanced draft regulators, boiler meters, ash hoppers and gates, coal bunkers, coal handling equipment, dual drive heat balance set and complete switchboard, estimated cost $400,000. C. DeVault, Martins' Ferry, is service director, R. R. Schweitzer, Windsor Hotel, Wheeling, W. Va., is consulting engineer.

Tex., Crawford—The City is having plans prepared for water-works improvements, to include a 65 ft. tower, 50,000 gal. tank, 3,500 ft. 6 in. main and pumping equipment. Estimated cost $17,000. J. B. Hawley, 403 Cotton Exchange Bldg., Ft. Worth, is engineer.

Tex., Greenville—The City, J. O. Willman, Clk., awarded the contract for equipment to increase power generated at municipal light and water plant, to J. U. Jones, 908 Western Ind. Bldg., Dallas, estimated cost $52,000.

Tex., Mineola—J. Carpenter, Archt., c/o Mineola Ice, Light & Water Co. (owner), is receiving bids for the construction of a 1 story addition to ice plant; estimated cost $43,000.

Tex., O'Donnell—The City Commissioners plan to hold an election to vote on $30,000 bonds for waterworks improvements, including additional pumping equipment, etc.

Wash., Camas—Camas Lumber Co., J. O. Storey, Pres., is in the market for complete line of machinery, including engines and boilers, electric driven, also electric generator and lighting plant.

Wash., Dryden—Puget Sound Light & Power Co., Stuart Bldg., Seattle, plans to enlarge its generating plant here. Plans include enlargement of power house, increasing capacity of unit from 1600 hp. to 3100 hp., new penstock and additional generating equipment. Estimated cost, $75,000.

Wash., Puget Sound—Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans extension to boiler plant and distribution system at Navy Yard, here.

Wis., Milwaukee—Greater Wisconsin Association, c/o Milwaukee Association of Commerce, Broadway and Oneida Sts., plans to construct a cold storage plant; estimated cost, $1,000,000.

Wis., Sheboygan—E. R. Godfrey & Sons, 294 Broadway, Milwaukee, are in the market for refrigeration machinery for proposed 3 story warehouse to be constructed in Sheboygan by Gutsch Brewing Co., 1012 New York Ave., Sheboygan, and to be occupied by them.

B. C., Vancouver—D. Spencer, Ltd., Hastings St., is having preliminary plans prepared for the construction of a 10 story department store at Cordova and Richard Sts., estimated cost $1,500,000. McCarter & Vairne, 509 Richards St., are architects.

Que., Sherbrooke—H. L. Stevens & Co., 522 5th Ave., New York City, will soon receive bids for the construction of a 6 story hotel, on North Wellington St., here estimated cost $750,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Price advances continue in excess of declines in the current market for power-plant and electrical supplies. Babbitt metal and other non-ferrous metal products are higher than a month ago. Linseed oil (barometrical of paint materials) is also above levels of Nov. 11. Flexible cord and rubber-covered copper wire are up. Recessions are reported in boiler rivets and armored cable, from prices prevailing one month ago. Steel, however, is increasing in firmness owing to improvement in demand. Advances in belting prices are predicted, soon after the first of the year, owing to increasing costs of raw materials.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		56c. per ft.
Common, 2½-in., 3-ply	80c. per ft. list less	50–10%

Air—Best grade

¾-in., per ft.	3-ply $0.36	4 ply	$0.44⅓

Steam—Discounts from List

First grade	30–5%	Second grade	40–5%	Third grade	50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40–2½%
Heavy	30–5%

RAWHIDE LACING
For cut, best grade, 45–5%, 2nd grade, 55%.
For laces in sides, best, 41c. per sq.ft.; 2nd, 37c.
Semi-tanned: cut, 45–5%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	14@21	19.00	14.00
Colored	9@14.50	18.00	10.50

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13½ x 13½	13½ x 20½
Chicago	16.00	16.00
New York (white, at washeries)	11.00@11.25	.....
Cleveland	$36.00 per M.	$50.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.11	$1.15	$1.05

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	15.25	14.00	16.75	15.50
White	15.25	14.00	15.25	14.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ⅞x1-in. and longer, 19c. per lb., less 60% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ¾-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ½, ⅝, ¾ in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$3.75	Chicago	$3.65	Pittsburgh	$2.60

Boiler rivets, same sizes:

New York	$3.85	Chicago	$3.75	Pittsburgh	$2.75

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$47@52
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	22@27
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	26@31
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	42@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@42
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	37@39
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	37@39
Chrome ore crude, 40@50%	net ton	17.00@19.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	64.50	48@52
(35% tin)	28.00	19.50	23@26

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.05	$3.90	$3.[illegible]
Flats, squares and hexagons, per 100 lb. base	4.55	4.40	4.30

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
2	.20	.25	.21
2¼	.23	.29	.23
2½	.24	.33	.28
2¾	.....	.....	.....
3	.30	.41	.32
3½	.32	.47	.35
3¾	.34	.51	.37
4	.43	.64	.47

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2¼ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$38.00 (net)	$ 56.50 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	25%
Coils to 1,000 ft.	55%	30%
1,000 to 5,000 ft.	60%	35%
5,000 ft. and over	60–5%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$58.92	$63.77	$9.56	$10.64	$5.52	$5.92
⅜	75.35	81.90	12.58	14.01	7.88	8.45
½	108.15	117.84	18.62	20.73	10.25	10.99
¾	146.33	159.44	24.78	27.35	14.21	15.18
1	174.96	190.63	33.04	36.46	17.55	18.75
1¼	235.39	256.48	60.58	66.85	23.41	25.00
1½	372.18	405.52	99.13	109.39	33.43	35.71
2	486.69	530.30	264.34	291.70	50.14	53.56
2½	611.52	663.96	583.74	644.16	66.86	71.42
3	745.53	807.36	674.61	774.43	83.57	89.27

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$22.50
No. 16 cotton reinforced heavy	25.45
No. 18 cotton reinforced light	17.75
No. 16 cotton reinforced light	22.20
No. 18 cotton Canvasite cord	17.50
No. 16 cotton Canvasite cord	20.50

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500)	$2.85
0–30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.55	.60	24
40	.27	.32	120	150	.70	.75	24
50	.27	.32	120	200	.95	1.05	24
60	.32	.37	120	300	1.50	1.60	24
				500	2.25	2.40	12
				750	3.75	3.95	8
				1,000	4.00	4.25	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6.95	$8.94	$10.75	$17.10
12	9.20	11.86	13.50	22.50
10	12.25	15.56	17.20	30.50
8	17.31	20.75	23.00	35.00
6	.....	.....	32.75	.....
4	.....	.....	45.48	.....
2	.....	.....	67.00	.....
1	.....	.....	85.46	.....
0	.....	.....	114.75	.....
00	.....	.....	138.00	.....
000	.....	.....	164.00	.....
0000	.....	.....	195.00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¾ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Rubber tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%